#686

INSTRUCTION MANUAL

REGULATED POWER SUPPLIES

LP SERIES

MP MASTER
MA28846

LAMBDA

LAMBDA ELECTRONICS CORP.–MELVILLE, L. I., N. Y.

INSTRUCTION MANUAL

FOR

REGULATED POWER SUPPLIES

LP SERIES

This manual provides instructions intended for the operation of Lambda power supplies, and is not to be reproduced without the written consent of Lambda Electronics Corp. All information contained herein applies to metered and non-metered LP models unless otherwise specified.

LAMBDA ELECTRONICS CORP. 69 MELVILLE, L. I., N. Y.
MAIN PLANT TELEPHONE: 516 MYrtle 4-4200

IM-LP400

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SPECIFICATIONS AND FEATURES

Specifications apply for the non-metered and the metered models.

DC OUTPUT--Voltage regulated for line and load

Voltage Range.....TABLE I

VOLTAGE RANGE

MODEL	LP-410	LP-411	LP-412	LP-413	LP-414	LP-415
VOLTAGE RANGE VDC	0-10	0-20	0-40	0-60	0-120	0-250

Multi-Current Ranges.....Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range.

TABLE II

MAX. CURRENT

MODEL	MAX. CURRENT AT AMBIENT OF:			
	30°C	40°C	50°C	60°C
LP-410	2A	1.8A	1.6A	1.4A
LP-411	1.2A	1.1A	1.0A	0.8A
LP-412	0.70A	0.65A	0.60A	0.50A
LP-413	0.45A	0.41A	0.37A	0.33A
LP-414	0.20A	0.18A	0.16A	0.12A
LP-415	80MA	72MA	65MA	60MA

REGULATED VOLTAGE OUTPUT

Regulation (line).....0.01 percent plus 1.0 millivolt for input variations from 105-132 or 132-105 volts AC

Regulation (load).....0.01 percent plus 1.0 millivolt for load variations from no load to full load or full load to no load

Remote Programming

External Resistor .....Nominal 200 ohms/volt output

Programming Voltage.....One-to-one voltage change

Ripple and Noise .....500 microvolts rms; 1.5 millivolts peak-to-peak with either positive or negative terminal grounded

Temperature Coefficient .....Output change in voltage less than (0.015% + 0.5 mv) /°C

DC OUTPUT--Current regulated for line and load; automatic crossover with voltage limit

Multi-Current Ranges .....Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range. For maximum current range see Table II. Minimum current 1% of 30° ambient rating in Table II or 5 ma., whichever is greater.

Voltage Range .....For voltage range see Table I; voltage ratings apply for entire current range.

REGULATED CURRENT OUTPUT; AUTOMATIC CROSSOVER

Regulation (line) .....Less than 0.2% or 5 milliamperes, whichever is greater, variations from 105-132 or 132-105 volts AC

Regulation (load) .....Less than 0.2% or 5 milliamperes, whichever is greater, for load voltage changes from 0 to max. or max. to 0 volts DC

AC INPUT--105-132 volts AC at 45-440 Hz. For input power see Table III.

TABLE III
INPUT POWER, WATTS*

MODEL	INPUT POWER
LP-410	85 Watts
LP-411	75 Watts
LP-412	70 Watts
LP-413	65 Watts
LP-414	60 Watts
LP-415	50 Watts

*With output loaded to full 30°C rating and input voltage 132 volts AC, 60 Hz

OVERLOAD PROTECTION

Thermal ..... Thermostat, resets automatically when over-temperature condition is eliminated

Electrical

External ..... Adjustable, automatic, electronic current-limiting circuit, settable to 105 percent of rated current; limits output current to preset limit for protection of load and power supply when external overloads and direct shorts occur

Internal ..... Fuse, "SLO-BLO", 1.5A, fuse F1 protects the AC input circuit. Overload of the supply does not cause fuse failure

Fuse F2 provides protection against internal circuit failure in conjunction with overvoltage protector option

INPUT AND OUTPUT CONNECTIONS--Heavy duty terminal block on rear of chassis with 5-foot, 3-wire detachable line cord for all models; five-way binding posts provide for additional positive (+), ground, and negative (-) DC output connections, on front panel of FM models

OVERSHOOT--No overshoot of output voltage under conditions of power turn-on, power turn-off or power failure

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE--Continuous duty from 0°C to 60°C ambient with corresponding load current ratings for all modes of operation

STORAGE TEMPERATURE-(non-operating) -55°C to +85°C

METERS-Voltmeter and ammeter on metered suffix (FM) models

CONTROLS

DC output controls ..... Coarse and fine voltage controls and coarse and fine current controls permit adjustment of DC output; located on front panel of all models

Binding Posts (+) (-) (GND).... Five-way binding posts on FM models.

Remote Sensing. . . . . Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

Power. . . . . Panel mounted switch and indicator light for all units

Test Jacks (+) (-). . . . . Test jacks for non-metered models permit checking DC voltage output with external meters

PHYSICAL DATA

Size	5-3/16"H x 4-3/16"W x 10"D
Weight	7 lbs. net; 8 lbs. shipping wt.
Panel Finish	Brushed aluminum clear anodized panels with grey inlay (standard); special finishes available to customer's specifications at moderate surcharge

MOUNTING:

Laboratory bench, table top	Bumpers secured to the base of all LP units permit proper circulation of air through the unit. Removal of bumpers will restrict free-flow of air through the unit, avoid removing bumpers
Standard 19" Rack	All LP units can be used with rack adapters: LRA-1 (slide accomodation provided) LRA-2 (conventional mount) See figure 13

MODEL OPTIONS

Suffix "R" Fungus Proofing Option	Standard LP power supplies can be obtained with fungus proofing treatment with MIL V 173 varnish for all fungi nutrient components
Suffix "FM" Meter Option	Standard LP power supplies can be obtained with voltmeter and ammeter.
Suffix "V" Option	Standard LP power supplies can be obtained for 205-265 VAC, 50 Hz input

ACCESSORIES

Rack Adapters	Rack adapter LRA-1, with or without chassis slides is available as well as rack adapter LRA-2 which is used for simple rack installations where chassis slides are not required
Blank Panels	Half-rack and quarter-rack panels can be used with the Lambda rack adapters, see figure 13
Overvoltage Protector	Externally mounted, Overvoltage Protectors LHOV-4, LHOV-5 and LHOV-6 are available for use with LP power supplies LP-410, LP-411, LP-412 and LP-413

THEORY OF OPERATION

GENERAL

The Lambda power supply consists of an AC input circuit and transformer; a bias supply consisting of an auxiliary rectifier and filter, and preregulator; a main regulator circuit consisting of the main rectifier and filter, a series regulator, emitter follower driver(s), a current comparator, a voltage comparator, a voltage amplifier, current and voltage sensing networks and a voltage reference circuit.

The circuit arrangement is shown in block diagram form, Figure 10. The circuitry is discussed with reference to the block diagram and the schematic diagram.

FUNCTIONAL DESCRIPTION

Single phase input power is applied to transformer T1 through the input circuit containing a built-in thermostat and fuse F1, which protect the supply against overheating and internal faults.

The main rectifier, a full-wave rectifier, provides the power which is filtered by capacitor C9 and then regulated via a series regulator and delivered to the output. Half-wave auxiliary rectifier CR1 provides voltage filtered by capacitor C2 for voltage amplifier Q4 and preregulator Q1. Preregulator Q1 provides regulated power for zener diode CR3, which is the reference element for the current sensing circuit, for current comparator Q2, Q3, voltage comparator Q5, Q6, and for Q7 and zener diode CR7, which together function as the voltage reference for constant voltage operation. CR8 provides voltage compensation which acts to reduce the effect of temperature changes on the emitter-base bias of Q7.

Constant voltage or constant current crossover circuit operation is determined by changes in the load. A change in the output voltage is sensed by voltage sensing divider R30A, B, which has a constant current of 5 milliamperes flowing in the divider element, determined by Q7 and the setting of calibration control R20. This output voltage variation causes a change to the input of Q6 of the voltage comparator, which compares it with the reference voltage determined by CR7, resulting in an error signal at the output of Q5. In constant voltage operation, the voltage across R29 is less than the preset voltage across R6A, B; Q2 and CR4 are at cutoff; Q3 is in saturation and CR6 is conducting. If the load current decreases, causing a rise in output voltage, Q6 conducts less, Q5 is biased toward cutoff and the current from R18 flows through OR gate diode CR6 instead of Q5. This action causes amplifier Q4 to conduct more heavily, reducing drive current to the base of driver Q8, causing the series regulator impedance to increase and the output voltage to decrease accordingly.

Simultaneously, Q2 of the current comparator samples the load current through current sensing resistor R29 and compares it with the reference voltage across current sensing divider R4, R5 and R6A, B, determined by zener diode CR3. In constant current crossover operation, the voltage across R29 is approximately equal to the preset voltage across R6A, B, Q2 will conduct and bias Q3 toward cutoff, causing the current from R10 to flow through OR gate diode CR4 instead of Q3. Similarly, this action will cause amplifier Q4 to conduct more heavily, reducing drive current to the base of Q8, causing the series regulator impedance to increase and the output voltage to decrease accordingly, effectively maintaining a constant current. This output voltage decrease, sensed by the voltage sensing network, causes Q6 to be reverse biased, turning it off and causes turn-on of Q5 till saturation occurs

and OR gate CR6 stops conducting. The unit now continues to function in the constant current mode of operation, with OR gate diode CR4 controlling the turn-on bias of Q4, which in turn controls the drive current to the series regulator and ultimately the output voltage of the supply.

In model LP-415 tandem transistors Q9, Q11 are used to share the total series regulator voltage. Resistors R32 and R33 fix the base of Q10 at approximately one-half of the total series regulator voltage. The emitter current from Q10 controls tandem regulator Q11, which tracks with Q9 to split voltage and power. For example, when voltage across Q9 increases due to a regulating action, the current in R32 and R33 also increases, causing base of Q10 to be biased toward cutoff which in turn biases Q11 toward cutoff so that the voltage across Q11 increases until the voltage across Q11 and Q9 are approximately equal.

OPERATING INSTRUCTIONS

CONTROLS, INSTRUMENTS AND FUSES

Power ON-OFF Switch. The power ON-OFF switch, located on the front panel, controls application of input power to the supply. When the switch is in the ON position, the red power on indicator glows.

OUTPUT VOLTAGE Control. The OUTPUT VOLTAGE control is a dual control consisting of a coarse adjustment potentiometer, which varies the DC voltage over a range of 0-9, 0-19, 0-39, 0-59, 0-117.5, 0-247.5 volts as applicable, and a fine adjustment potentiometer, which varies the DC voltage over a one-volt range.* Clockwise rotation results in increasing voltage. The total DC voltage output for voltage regulated operation is equal to the sum of each shaft setting; for current regulated operation the maximum voltage limit is equal to the sum of each shaft setting. The control is located on the front panel of all units.

*For models LP-414 and LP-415 the DC voltage fine adjustment range is 2.5 volts.

CURRENT LIMITER Control. The CURRENT LIMITER control is a dual control consisting of a coarse adjustment potentiometer, which varies the DC current over 90% of the rated current range* and a fine adjustment potentiometer, which varies the DC current over 10% of the rated current range. Clockwise rotation results in increasing current. The total DC current output for current regulated operation, is equal to the sum of each shaft setting; for voltage regulated operation the maximum current limit is equal to the sum of each shaft setting. The control is located on the front panel of all units.

*Operation for output current below rated limits can result in no output or no regulation.

Output Voltage Meter. A DC voltmeter monitors the voltage at the output terminals of metered (FM) units for the rated voltage range.

Output Current Meter. A DC ammeter monitors the load output current of metered (FM) units for the rated current range.

Fuses. Fuse F1, internally located, is a 1.5 ampere, 3AG "SLO-BLO" fuse which functions in the AC input circuit.

Fuse F2, internally located, provides protection against internal circuit failure. See schematic diagrams for current ratings of pertinent F2 fuse.

Connection Terminals. Make all connections to the supply at the terminal block on the rear of the supply. DC output connections can also be made at the five-way binding posts located on the front panel of FM models. Apply input power through the line cord or directly to terminals 1 and 2 if the line cord is removed. Always connect the ungrounded (hot) power lead to terminal 1.

The supply positive terminal is brought out to terminal 6. The supply negative terminal is brought out to terminal 4. Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 9. Selection of proper wiring is made on the basis of load requirements. Make all performance checks and measurements of current or voltage at the rear output terminals. Connect measuring devices directly to terminals or use the shortest leads possible.

GROUND CONNECTIONS

The Lambda power supply can be operated either with negative or positive output terminal grounded or with no terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

> NOTE: When operating the supply with neither terminal grounded, high impedance leakage resistance and capacitance paths can exist between the power supply circuitry and chassis ground.

BASIC MODES OF OPERATION

This power supply is designed to operate as a constant voltage source or as a constant current source. Automatic crossover to either mode of operation occurs when load conditions change as follows:

Constant Voltage. The power supply will function as a constant voltage source while the load current does not equal the current value, I_{LIM}, set by the CURRENT LIMITER control When load current $I_L = \frac{V}{R_L} = I_{LIM}$, the supply will cross over automatically and will operate as a constant current source. Further decrease in value of load resistance R_L results in decrease of voltage across the load while current remains regulated to I_{LIM}.

Constant Current (Automatic Crossover). The power supply will function as a constant current source while the load voltage V_L does not equal the voltage value set by the OUTPUT VOLTAGE control. When load voltage V_L equals the value set by the OUTPUT VOLTAGE control, the supply will automatically cross over and operate as a constant voltage source.

SUPPLY LOAD CONNECTIONS

> NOTE: Refer to DETAILED OPERATING PROCEDURES for step-by-step instructions for operation of power supply.

Connections For Operation as a Constant Voltage Source

The output impedance and regulation of the power supply at the load may change when using the supply as a constant voltage source and connecting leads of practical length are used. To minimize the effect of the output leads on these characteristics, remote sensing is used. Recommended types of supply-load connections with local or remote sensing are described in the following paragraphs.

Refer to figure 1 to determine voltage drop for particular cable length, wire size and current conditions. Lead lengths must be measured from supply terminals to load terminals as shown in figure 2.

Two-Wire Connection, Figure 3. The two-wire connection, with local sensing, is the connection suitable for application with relatively constant load.

Four-Wire Connection, Figure 4. The four-wire connection with remote sensing, provides complete compensation for the DC voltage drops in the connecting cables. Compensation for lead drop is also valid for gradual changes of load current.

Programmed Voltage Connections, Using External Resistor, Figure 5. Discrete voltage steps can be programmed with a resistance voltage divider valued at 200 ohms/volt output and a shorting-type switch as shown in figure 5. When continuous voltage variations are required, use variable resistor with the same 200 ohms/volt ratio in place of the resistive voltage divider and shorting-type switch. Use a low temperature coefficient resistor to assure most stable operation.

As shown in figure 5, voltages can be programmed utilizing either local or remote sensing connections, as desired.

Programmed Voltage Connections Using Programming Voltage, Figure 6. The power supply voltage output can be programmed with an externally connected programming power supply. The output voltage of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply.

The programming supply must have a reverse current capability of 6 ma. minimum.

Alternatively, when supplies with less than 6 ma. reverse current capability are used, a resistor capable of drawing 6 ma. at the minimum programming voltage must be connected across the output terminals of the supply. This programming supply must be rated to handle all excess resistor current at the maximum programming voltage.

Connections For Operation as a Constant Current Source

Automatic Crossover Constant Current Connections, Figure 3. Figure 3 shows the connections which are used when operating the power supply as a constant current source with automatic crossover, using local setting of current control*

*Setting control for output currents below rated limits can result in no output or no regulation.

In this mode of operation, when the load voltage increases, due to changing load resistance, to the limit of the OUTPUT VOLTAGE control setting, the power supply crossover circuit will cause the unit to operate as a constant voltage supply.

Connections For Series Operation

The voltage capability of LP power supplies can be extended by series operation of two LP power supplies of equal* voltage ratings. A maximum of 300 volts can be connected between either the +DC or -DC terminal and chassis ground, and a maximum voltage capability of 500 volts is possible for model LP415.

*For applications using supplies of unequal ratings, consult factory for details of operation.

Diodes CR_1 and CR_2, must each be capable of withstanding the maximum rated current of the units in the series combination, figure 7.

This method permits operation for either constant voltage or constant current with automatic crossover to either mode of operation whenever the respective limiting operating current or voltage is reached. Figure 7 shows connection for either local or remote sensing.

Connections For Parallel Operation

The current capability of LP power supplies can be extended by parallel operation of two LP power supplies of equal* voltage capacities. The two units are shown connected for parallel operation in figures 8, 9. One power supply designated the "master" or (M) unit controls its own output as well as the output of the second power supply, designated the "slave" or (S) unit.

*For applications using supplies of unequal voltage ratings, consult factory for details of operation.

Unit (S) operates to regulate its current in a ratio to that of the (M) unit by comparing the current in its internal sampling resistor with that current sampled by the master internal sampling resistor. When power supplies of unequal current capacities are parallel connected, the division of current supplied will be approximately equal to the ratio of the current ratings of the supplies.

Parallel connected units can be operated for constant voltage with local sensing, figure 8, or remote sensing, figure 9, as well as for constant current with automatic crossover, figure 8. When operating for constant voltage, the (M) unit can automatically cross over into constant current operation.

DETAILED OPERATING PROCEDURES

SAFETY NOTICE

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. OBSERVE THE USUAL SAFETY PRECAUTIONS WHEN OPERATING OR SERVICING THE EQUIPMENT TO AVOID SHOCK OR INJURY.

Constant Voltage Operation, Adjustable Current Limit

1. Remove AC power to the supply and place power ON-OFF switch in OFF position before connecting load to the supply.

2. Determine load requirements, select wire size from figures 1 and 2 and choose desired type of supply-load connection from figures 3 and 4.

3. Connect supply to load as shown on the selected connection diagram.

NOTE: When shipped from the factory, the supply is ready for use as a local-sensing constant voltage source with automatic crossover or as a constant current source. Jumpers are connected at the factory as shown in figure 3. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.

4. Turn OUTPUT VOLTAGE control knobs to the desired voltage setting.

5. When current to the load must be limited to an intermediate value within the current rating of the supply, turn the CURRENT LIMITER controls to the desired current limit setting. If no intermediate current limit is required, turn the control CW to the position for full current rating for the maximum ambient temperature of operation. Refer to section on Specifications and Features.

6. Apply AC power to the supply.

7. Place power ON-OFF switch in ON position and check that red power ON indicator is lit.

8. Check that output current* and output voltage meters indicate desired values; as required, adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER controls to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 6 and 4, or at front panel test jacks (+) and (-) for voltage checks only; for remote sensing connections, check at the load terminations of sensing leads on terminals 3 and 7.

*Ammeter indicates a nominal 5 milliamperes offset from zero, which is the sensing divider current and not load current. For load current use the 5 ma. point as zero point.

9. Power supply is now in proper operation.

Programmed Constant Voltage Operation, Adjustable Current Limit

1. Remove AC power input to the supply and place power ON-OFF switch in OFF position before connecting load to the supply.

2. Determine load requirements, select wire size and length from figures 1 and 2 and choose desired type of supply-load connection from figures 5 or 6. Refer to paragraph on Programmed Voltage Connections.

3. Connect supply to load as shown on the selected connection diagram. As shown in figure 5, take care to use a shorting-type switch for the external programming control when several voltages are desired and the programming voltage method is not used.

4. Turn OUTPUT VOLTAGE control knobs to the extreme CCW position. Adjust external programming voltage control to desired voltage setting.

5. When current to the load must be limited to an intermediate value within the current rating of the supply, turn the CURRENT LIMITER controls to the desired current limit setting. If no intermediate current limit is desired, turn the controls CW to the position for full rated current for the ambient temperature of operation. Refer to section on Specifications and Features.

6. Apply AC power to the supply.

7. Place power ON-OFF switch in ON position and check that red power ON indicator is lit.

8. Check that output current* and output voltage meters indicate desired values; as required, adjust CURRENT LIMITER controls and external programming voltage control to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4

and 6, or at front panel test jacks (+) and (-) for voltage checks only; for remote sensing connections check at the load terminations of sensing leads on terminals 3 and 7.

*Ammeter indicates a nominal 5 milliamperes offset from zero, which is the sensing divider current and not load current. For load current use the 5 ma. point as zero point.

Constant Current Operation With Crossover, Adjustable Voltage Limit

1. Remove AC power input to the supply and place power ON-OFF switch in OFF position before connecting load to the supply.

2. Determine load requirements, select wire size and length from figures 1 and 2 and connect load to the supply as shown in figure 3.

3. Turn the CURRENT LIMITER controls to the desired current setting.

4. When load voltage must be limited to an intermediate value within the voltage rating of the supply, turn OUTPUT VOLTAGE control knobs to the desired voltage limit setting. If no intermediate voltage limit, within rating of supply is desired, turn controls to the full CW position to obtain voltage limit at maximum voltage rating of the supply.

5. Apply AC power to the supply.

6. Place power ON-OFF switch in ON position and check that red power ON indicator is lit.

7. Check that output current* and output voltage meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER controls as required to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6, or at front panel test jacks (+) and (-) for voltage checks only.

*Ammeter indicates a nominal 5 milliamperes offset from zero, which is the sensing divider current and not load current. For load current use the 5 ma. point as zero point.

8. Power supply is now in proper operation.

Series Connection Constant Voltage Operation, With Current Limit

1. Remove AC power input to both units and place power ON-OFF switches in OFF position before connecting load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 2 and connect in accordance with figure 7. Refer to paragraph on Connections for Series Operation.

3. Select diodes CR_1 and CR_2 in accordance with instructions contained in Connections for Series Operation.

4. Turn OUTPUT VOLTAGE control knobs of both units to obtain the desired output voltage. These settings must be the output voltage for the combination.

5. When current to the load must be limited to an intermediate value within current rating of the units, turn the CURRENT LIMITER controls of each unit to a setting equal to

desired total current limit for the combination. If no intermediate current limit is required, turn the controls of each unit CW to the position for full current rating for the maximum ambient temperature of operation. Refer to section on Specification and Features.

6. Apply AC power to the supplies.

7. Place power ON-OFF switches of both units in ON position and check that red power ON indicators are lit.

8. Check that output current* and output voltage meters indicate desired values; total voltage is equal to sum of output voltage of both units. As required, adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER controls of the units to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals of both units; positive (+) terminal 6 of unit (1) and minus (-) terminal 4 of unit (2) are the output terminals of the series combination.

*Ammeter indicates a nominal 5 milliamperes offset from zero, which is the sensing divider current and not load current. For load current use the 5 ma. point as zero point.

Use front panel jacks (+) of unit (1) and (-) of unit (2) to make output voltage check for the series combination. For remote sensing connection, make checks at the load terminations of sensing leads from terminal 7 of unit (1) and from terminal 3 of unit (2).

9. Power supplies are now in proper operation.

Series Connection Constant Current Operation, With Voltage Limit

1. Remove AC power input to both units and place power ON-OFF switches in OFF position before connecting load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 2 and make supply-load connections shown in figure 7A. Refer to paragraph on Connections for Series Operation.

3. Select diodes CR_1 and CR_2 as instructed in Connections for Series Operation paragraph.

4. Turn CURRENT LIMITER controls of each unit to the desired setting.

5. When load voltage must be limited to an intermediate value within the voltage rating of the series combination, turn the OUTPUT VOLTAGE control knobs to a position for total intermediate voltage required for the combination. Total voltage is the sum of the voltage settings of each unit.

If no intermediate voltage limit is required, turn the controls to the full CW position to obtain voltage limit at the maximum combined ratings of the supplies.

6. Apply AC power to the supplies.

7. Place power ON-OFF switches of both units to ON position and check that red power ON indicators are lit.

8. Check that output current* and output voltage meters indicate desired values; total voltage is the sum of (1) and (2) unit voltages. As required, adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER controls of units to obtain correct indications. For non-metered models, use externally connected meters and check that correct meter indications exist at output terminals of the (1) and (2) units; positive (+) terminal 6 of (1) unit and minus (-) terminal 4 of the (2) unit are the output terminals of the series combination.

*Ammeter indicates a nominal 5 milliamperes offset from zero, which is the sensing divider current and not load current. For load current use the 5 ma. point as zero point.

Use front panel jacks (+) of (1) unit and (-) of (2) unit to make output voltage check on non-metered units.

9. Power supplies are now in proper operation.

Parallel Connection Constant Voltage Operation, With Current Limit

1. Remove AC power input to each supply and place power ON-OFF switch on both (M) and (S) units in OFF position before connecting load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 2 in the manual. Refer to paragraph on Connections for Parallel Operation.

3. Connect supplies to load as shown in connection diagram, figure 8 for local sensing, or figure 9 for remote sensing.

NOTE: When shipped from the factory, each supply is ready for use as a local-sensing constant voltage source with automatic crossover or as a constant current source. Jumpers are connected at the factory as shown in figure 3. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the connection diagram.

4. Turn OUTPUT VOLTAGE control knobs on the (M) unit to the desired voltage setting, and turn the output voltage controls on the (S) unit to fully CCW position.

5. When current to the load must be limited to an intermediate point, turn the CURRENT LIMITER controls on both the (M) and (S) units to the desired current limit setting. Set current limit control on the (M) and (S) units to the position indicating the current value to be delivered by the respective unit. If no intermediate current limit is desired, turn the controls CW on both (M) and (S) units to the position for full rated current for the maximum ambient temperature of operation. Refer to section on Specifications and Features.

6. Apply AC power to each supply.

7. Place power ON-OFF switches on (M) and (S) units in ON position and check that red power ON indicators are lit.

8. Check that output current* and output voltage meters on both (M) and (S) units indicate desired values; as required, adjust OUTPUT VOLTAGE controls and CURRENT LIMITER controls on (M) unit to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at

output terminals 4 and 6 of the (M) unit, or at front panel jacks (+) and (-) of the (M) unit for voltage check only; for remote sensing connection, check at the load termination of sensing leads on terminals 3 and 7 of the (M) unit.

* Ammeter indicates a nominal 5 milliamperes offset from zero, which is the sensing divider current and not load current. For load current use the 5 ma. point as zero point.

9. Power supplies are now in proper operation.

Parallel Connection Constant Current Operation, With Voltage Limit

1. Remove AC power input to each supply and place power ON-OFF switch on both (M) and (S) units in OFF position before connecting load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 2 and connect load to the supplies as shown in figure 8. Refer to paragraph on Connections for Parallel Operation.

3. Turn the CURRENT LIMITER control knobs on (M) unit to the desired current setting. Turn OUTPUT VOLTAGE control knobs on the (S) unit to full CCW position.

NOTE: When setting the CURRENT LIMITER knobs on the (M) and (S) units take care to set the control so that each unit indicates the proportion of total current that the unit must supply.

4. When load voltage must be limited, turn OUTPUT VOLTAGE control knobs on the (M) unit to the desired voltage limit setting. If no voltage limit within rating of the supply is desired, turn controls on the (M) unit to the full CW position.

5. Apply AC power to each supply.

6. Place power ON-OFF switches on (M) and (S) units in ON position and check that red power ON indicators are lit.

7. Check that output current* and output voltage meters on both units indicate desired values; adjust OUTPUT VOLTAGE controls and CURRENT LIMITER controls, as required, to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6 of the (M) unit, or at front panel jacks (+) and (-) of the (M) unit for voltage check only.

*Ammeter indicates a nominal 5 milliamperes offset from zero, which is the sensing divider current and not load current. For load current use the 5 ma. point as zero point.

8. Power supplies are now in proper operation.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown

The thermostat opens the input circuit only when the temperature of the transformer exceeds a maximum safe value. The thermostat will automatically reset when the temper-

ature of the transformer decreases to safe operating value. After eliminating the cause(s) for overheating and allowing time for the power supply to cool to a proper temperature, resume operation of the supply. Refer to appropriate operation paragraph in DETAILED OPERATING PROCEDURES.

Fuse Shutdown

Internal component failure is prevented by fuses which protect the components from damage caused by excessive currents. Fuses will blow when the maximum rated current value for the fuse is exceeded. Fatigue failure of fuses can occur when mechanical vibrations from the installation combine with thermally induced stresses to weaken the fuse metal. Many fuse failures are caused by a temporary condition and replacing the blown fuse will make the fuse protected circuit operative. When the LP unit is used with the overvoltage protector option, fuse F2 will provide protection against internal component failure.

MAINTENANCE

GENERAL

This section describes trouble analysis routine, replacement procedures, calibration and test procedures that are useful for servicing the Lambda power supply. A trouble chart is provided as an aid for the troubleshooter. Refer to the section on specifications and features for the minimum performance standards.

TROUBLE ANALYSIS

Whenever trouble occurs, systematically check all fuses, primary power lines, external circuit elements, and external wiring for malfunction before trouble shooting the equipment. Failures and malfunctions often can be traced to simple causes such as improper jumper and supply-load connections or fuse failure due to metal fatigue.

Use the electrical schematic diagram and block diagram, figure 10, as an aid to locating trouble causes. The schematic diagram contains various circuit voltages that are averages for normal operation. Measure these voltages using the conditions for measurement specified on the schematic diagram. Use measuring probes carefully to avoid causing short circuits and damaging circuit components.

CHECKING TRANSISTORS AND CAPACITORS

Check transistors with an instrument that has a highly limited current capability. Observe proper polarity for PNP or NPN to avoid error in measurement. The forward transistor resistance is low but never zero; backward resistance is always higher than the forward resistance.

For good transistors, the forward resistance for any junction is <u>always</u> greater than zero.

Do not assume trouble is eliminated when only one part is replaced. This is especially true when one transistor fails, causing other transistors to fail. Replacing only one transistor and turning power on, before checking for additional defective components could damage the replaced component.

When soldering semi-conductor devices, wherever possible, hold the lead being soldered with a pair of pliers placed between the component and the solder joint to provide an effective heat sink.

<u>NOTE</u>: The leakage resistance obtained from a simple resistance check of a capacitor is <u>not</u> always an indication of a faulty capacitor. In all cases the capacitors are shunted with resistances, some of which have low values. Only a dead short is a true indication of a shorted capacitor.

PRINTED CIRCUIT BOARD MAINTENANCE TECHNIQUES

1. If foil is intact but not covered with solder it is a good contact. Do not attempt to cover with solder.

2. Voltage measurements can be made from either side of the board. Use a needle-point probe to penetrate to the wiring whenever a protective coating is used on the wiring. A brass probe can be soldered to an alligator clip adapted to the measuring instrument.

3. Wherever possible use a heat sink when soldering transistors.

4. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.

5. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process described below:

(a) Select a 3/16 inch tinned copper braid for use as a wick; if braid is not available, select AWG No. 14 or No. 16 stranded wire with 1/2 inch insulation removed.

(b) Dip the wick in liquid rosin flux.

(c) Place the wick onto the soldered connection and apply soldering iron onto the wick.

(d) When sufficient amount of solder flows onto the wick, freeing the component, simultaneously remove iron and wick.

TROUBLE CHART

The trouble chart is intended as a guide for locating trouble causes, and is used along with the schematic diagram.

The operating conditions assumed for the trouble chart are as follows:

(a) AC power of proper voltage and frequency is present at input terminals.

(b) Either positive or negative terminal is connected to chassis ground.

(c) The power supply is connected for constant voltage with local sensing. See schematic; dotted lines indicate jumpers connected for local sensing operation.

TROUBLE SHOOTING CHART

Symptom	Probable Cause	Remedy
1. Power ON lamp DS1 does not light with power ON-OFF switch in ON position; no output voltage	No power input; power ON-OFF switch S1 defective; defective fuse F1; thermostat open, fuse F1 blown	Check power source, line cord and line cord plug; replace S1; replace F1; shut off unit, allow to cool and check ambient temperature
		Replace F1; if it blows immediately, check diodes CR20, CR21 or as applicable CR12, CR13, CR16, CR17 and capacitor C9, replace as necessary
2. Unable to adjust output voltage	Damaged OUTPUT VOLTAGE controls	Check R30A and R30B for shorts and/or open, replace as necessary
	Supply operating as constant current source with cross-over at CURRENT LIMITER setting	Remove load and check for shorts and/or improper supply-load connections; refer to appropriate diagram for correct connections
3. Zero volts DC output, with power ON indicator lit	OUTPUT VOLTAGE controls turned fully CCW	Check OUTPUT VOLTAGE controls for proper setting and correct as necessary
	Short circuit across output of supply	Check load and load connections, correct as necessary
	Series regulator section open	Check Q9, and, as applicable, Q11 for open, replace as necessary
	Open Q2, CR14, CR15, CR18, CR19 as applicable	Check Q2, CR14, CR15, CR18, CR19 as applicable for open, replace as necessary
	Emitter follower(s) open	Check Q8 and as applicable Q10 for open, replace as necessary
	Current sensing resistor open, or, on LP-414 ONLY, emitter resistors R35, R41 open	Check R29 for open; replace as necessary; check R35, R41 for open and replace as required

TROUBLE SHOOTING CHART (cont'd)

Symptom	Probable Cause	Remedy
(step 3 cont'd)	Improper voltage reference as indicated by voltage measurement across R20-R21 and CR7; aux. rectifier CR1 open	Check Q7 for open, CR8 and CR7 for short or CR1 for open; replace as necessary
4. High ripple at line frequency or twice line frequency and unregulated DC output	Series regulator transistors shorted emitter followers shorted; voltage amplifier open	Check and replace as necessary: Q9 (Q11) (Q12); Q8 (Q10); Q4
	Defective main rectifier causes ripple at twice line frequency	CR20, CR21 (CR12) (CR13) (CR16) (CR17) in addition to Q4; Q8 (Q10); Q9, (Q11) (Q12)
	Line voltage too low	Check and correct AC input voltage at supply terminals
5. Same as 4, except intermittent	Foreign matter fallen into unit	Check for loose bench hardware and wire clippings that may have fallen through cover
	Emitter follower Ico resistors open or changed value causing thermal run-a-way	Check R26, R27, R43 (R44) (R34) values and replace as necessary
6. High ripple at frequency other than line or twice line frequency	Oscillation due to defective component in filter network	Check for open C12, C13 and check for open and/or short in R14 and C6, R8 and C3, C5 and R22 networks and replace defective component
7. Large spikes at output	Capacitor C7, C8, C1, (C14) open, resistor (R45) open	Replace C7, C8, C1, as necessary, or R45, C14 as applicable

ADJUSTMENT OF CALIBRATION CONTROLS

Whenever parts are replaced, adjust calibration controls only when voltage and current indications are improper and do not reflect maximum ratings.

Adjust Voltage Calibration Control R20 as Follows:

1. Remove AC power input to the supply and place power ON-OFF switch in OFF position.

2. Unsolder wiper of R20 from resistor housing.

3. Operate the power supply for constant voltage with local-sensing jumpers connected as shown in figure 3, and no external load.

4. Turn OUTPUT VOLTAGE control knobs fully clockwise and, using a DC voltmeter of one percent accuracy or better, adjust R20 to provide output voltage E_O MAX + 25°C ambient; where E_O MAX is rated output voltage of the supply.

5. After adjustment is completed, remove AC power input to the supply and solder wiper of R20 to potentiometer housing.

Adjust Current Calibration Control R4 as Follows:

1. Remove AC power input to the supply and place power ON-OFF switch in OFF position.

2. Unsolder wiper of R4 from resistor housing

3. Turn OUTPUT VOLTAGE control knobs and CURRENT LIMITER controls fully CW.

4. Operate the power supply for constant current crossover, connected as shown in figure 3, with a short circuit across the output terminals.

5. Adjust R4 for 105% of full current rating at 30°C ambient, using any DC ammeter of one percent accuracy or better.

6. After adjustment is completed, remove AC power input to the supply and solder wiper of R4 to potentiomenter housing.

PERFORMANCE CHECKS

Checks With Constant Voltage Operation

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 11. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC VTVM (John Fluke Model 801H or equivalent) to the selected power supply operating voltage.. Check the power supply load regulation accuracy while switching from the load to no-load condition. Long load leads should be a twisted pair to minimize AC pick-up.

Use a Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power-supply line regulation accuracy on the VTVM differential meter.

Use a VTVM, Ballantine 320 or equivalent, to measure rms ripple voltage of the power supply DC output. Use oscilloscope to measure peak-to-peak ripple voltage of the power supply DC output.

Check With Constant Current Operation

Check the ripple or regulation of the power supply using the test connection diagram shown in figure 12. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Check the power supply load regulation accuracy while switching from the short circuit to load condition. Measure the voltage across sensing resistor Rs. Use John Fluke Model 801H or equivalent for the VTVM connected across Rs. For Rs, use a resistor having the same value as resistor R29 in the unit being tested. To obtain regulation figure, substitute values obtained into regulation formula:

$$\frac{\Delta E}{Rs} = \text{Regulation in milliamperes,}$$

where ΔE is the voltage change in millivolts and Rs is the resistance of the sensing resistor

Use a Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power supply line regulation accuracy using VTVM and the regulation formula:

$$\frac{\Delta E}{Rs}$$

To measure rms ripple current of the power supply DC output, use a Ballantine Model 320 or equivalent meter and obtain ripple current Ir by substituting measured values into formula:

$$\frac{\text{V.A.C. rms}}{Rs} = Ir$$

REMOVAL OF PRINTED CIRCUIT BOARD FOR SERVICING

1. Remove four 4-40 x 5/16 screws securing unit cover to the chassis and remove cover.

2. Remove three 6-32 x 3/8 screws from the bottom of the power supply that secure the inner assembly frame to the bottom of the chassis.

NOTE: Do not remove screws securing bumper feet to the chassis.

3. Remove two 6-32 x 5/16 screws, one from each side of the chassis, that secure the chassis to the bottom of the front panel assembly.

4. Remove two 6-32 x 3/8 screws securing nameplate on the rear of the chassis.

5. Remove two 6-32 x 3/4 screws securing terminal-block cover on terminal block and remove cover. Disconnect power cord from the terminal block.

6. Carefully remove inner assembly frame together with attached front panel, printed circuit board, capacitor bracket and rear terminal block from the chassis.

7. To detach printed circuit board together with attached capacitor bracket and rear terminal block, proceed as follows:

a. Remove two no. 6 hex nuts* securing capacitor bracket to the inner assembly frame, located on the side opposite to the printed circuit board. Do not remove the two button-head, socket-cap screws securing the capacitor bracket to the printed circuit board.

*On some units hex nuts and fixed threaded studs are not used to secure the capacitor bracket to the frame; on those units remove two 6-32 x 5/16 screws that secure the capacitor bracket to the inner assembly frame.

b. Remove four 6-32 x 1/2 screws, one from each corner of the printed circuit board, that secure the printed circuit board to the inner assembly frame.

c. Carefully swing the printed circuit board, together with attached capacitor bracket and rear terminal block, away from the inner assembly frame. Printed circuit board can now be serviced.

8. To reassemble unit, follow disassembly procedure in reverse order.

SERVICE

When additional instructions are required or repair service is desired, contact the nearest office of the Lambda Electronics Corp. where trained personnel and complete facilities are ready to assist you.

Please include the power supply model and serial number together with complete details of the problem. On receipt of this information, Lambda will supply service data or advise shipping for factory repair service.

All repairs not covered by the warranty will be billed at cost and an estimate forwarded for approval before work is started.

PARTS ORDERING

Standard components and special components used in the Lambda power supply can be obtained from the factory. In case of emergency, critical spare parts are available through any Lambda office.

The following information must be included when ordering parts:

1. Model number and serial number of power supply and purchase date.

2. Lambda part number.

3. Description of part together with circuit designation.

4. If part is not an electronic part, or is not listed, provide a description, function, and location of the part.

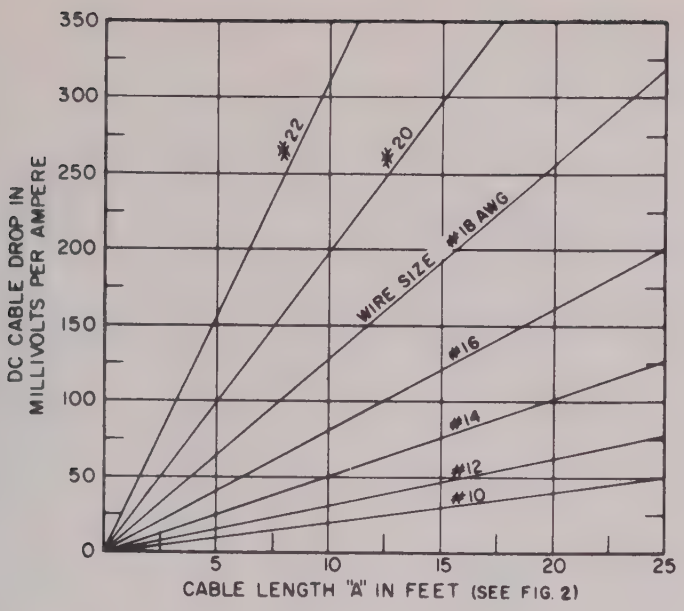


Figure 1. Cable Connection Chart

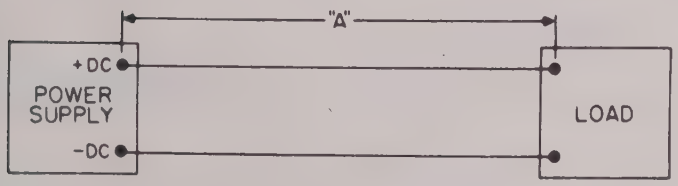
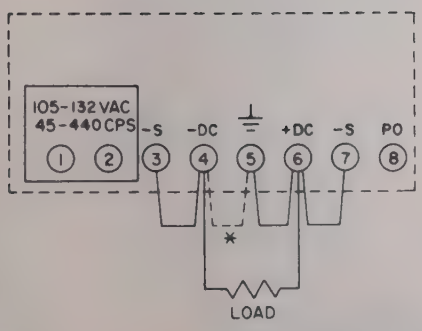
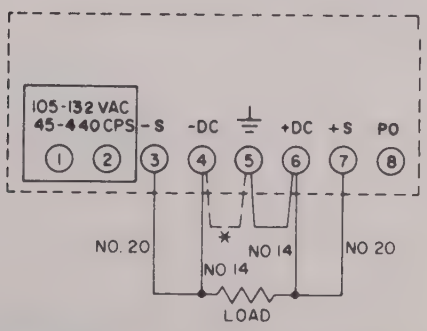


Figure 2. Cable Length "A" in Feet



NOTE.
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5

Figure 3. Two-Wire Connection



NOTE.
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5

Figure 4. Four-Wire Connection

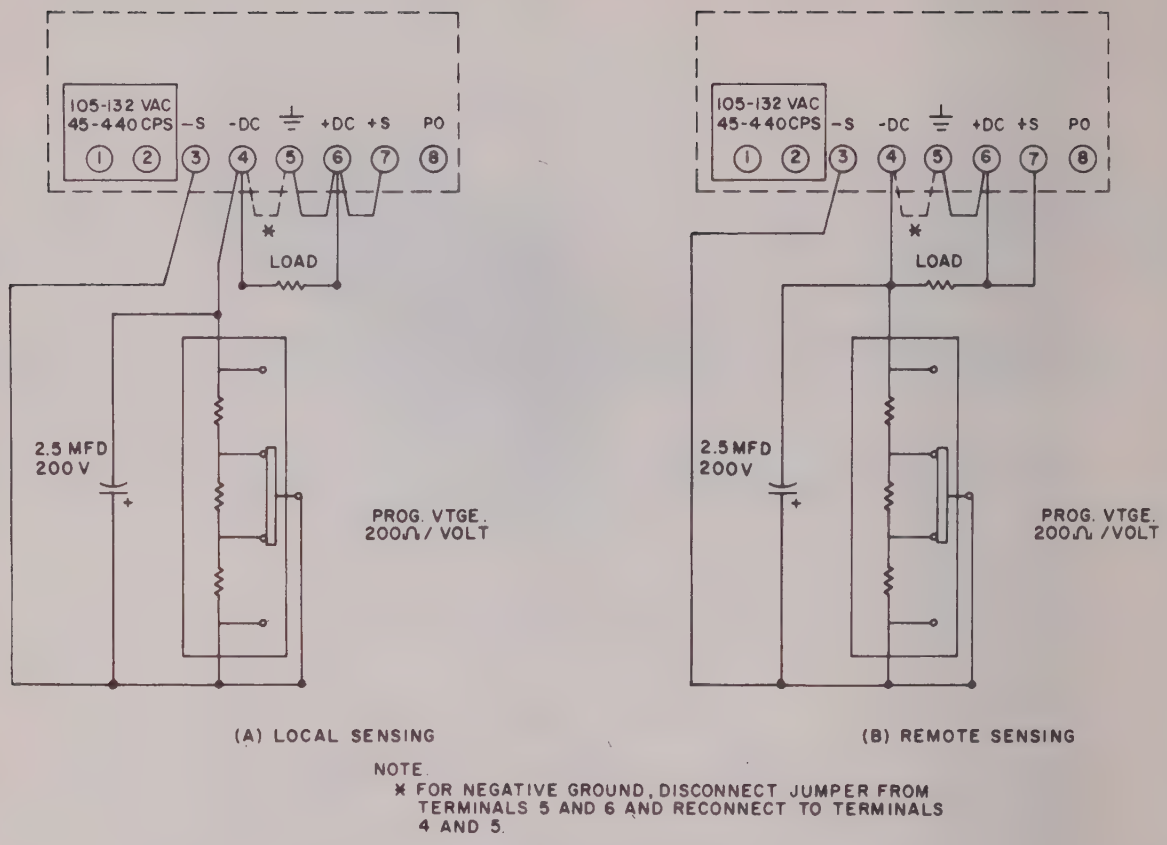


Figure 5. Programmed Voltage, With External Resistor

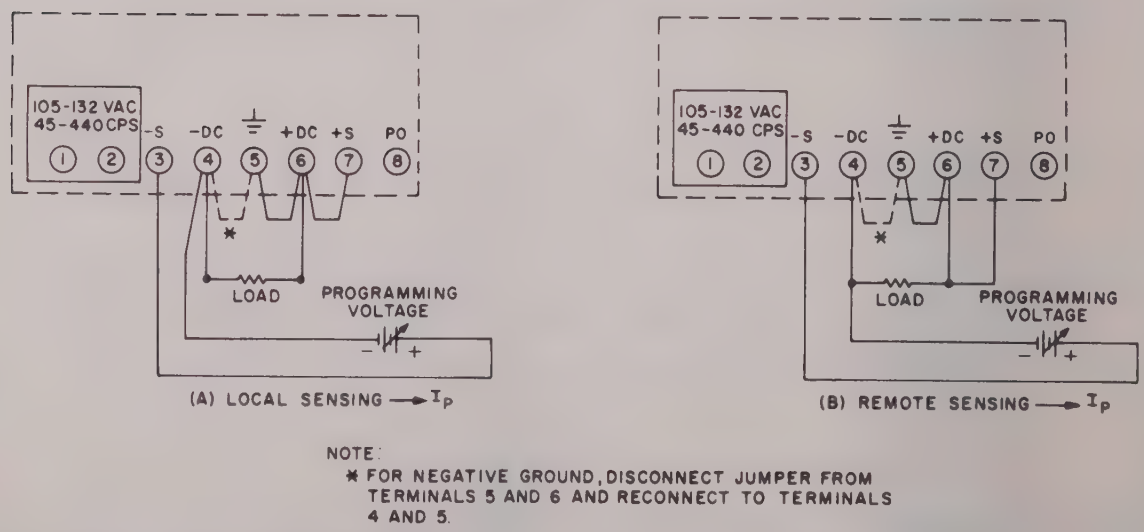
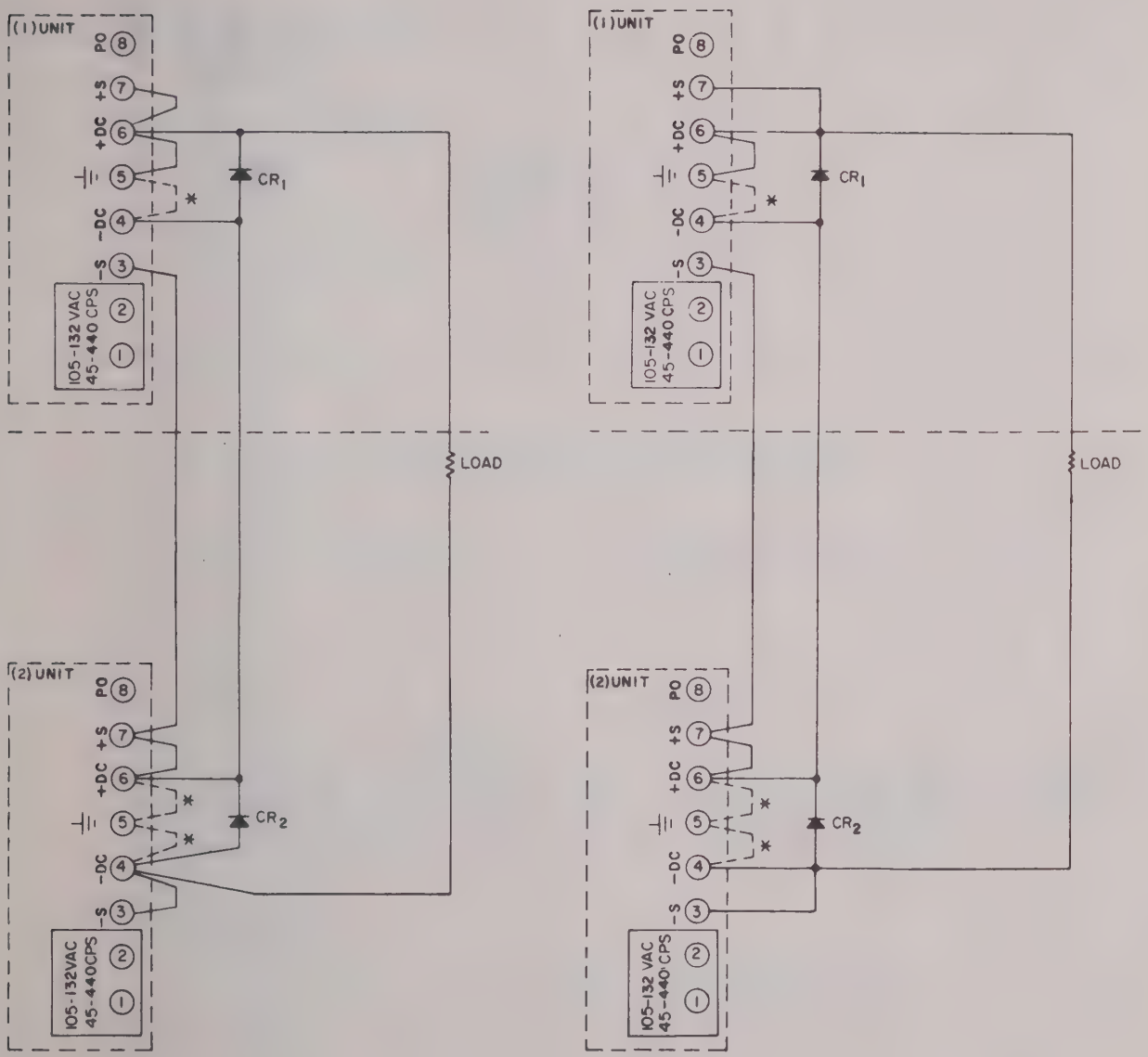


Figure 6. Programmed Voltage, With External Programming Voltage Source



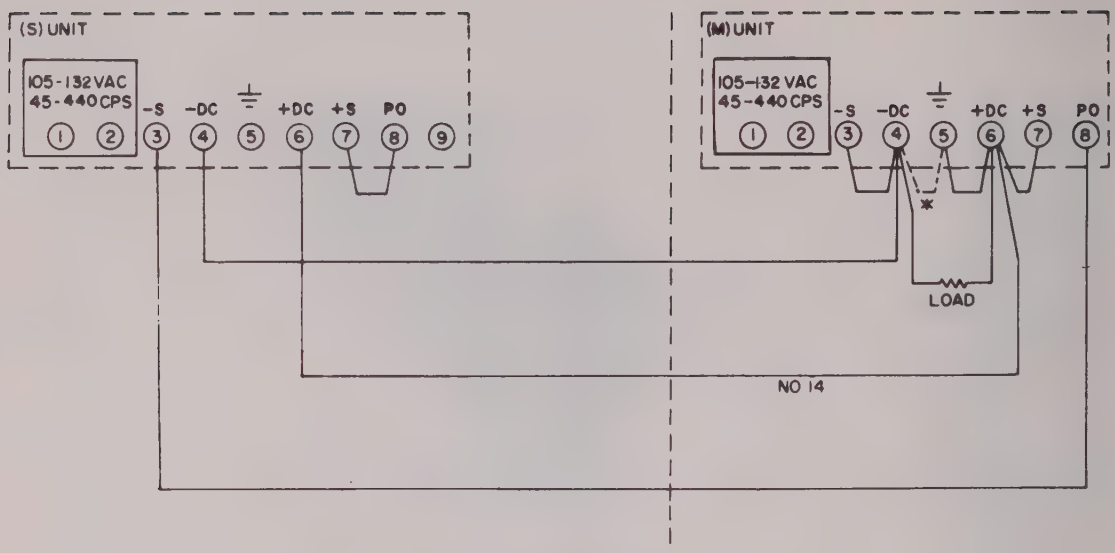
(A) LOCAL SENSING

(B) REMOTE SENSING

NOTE

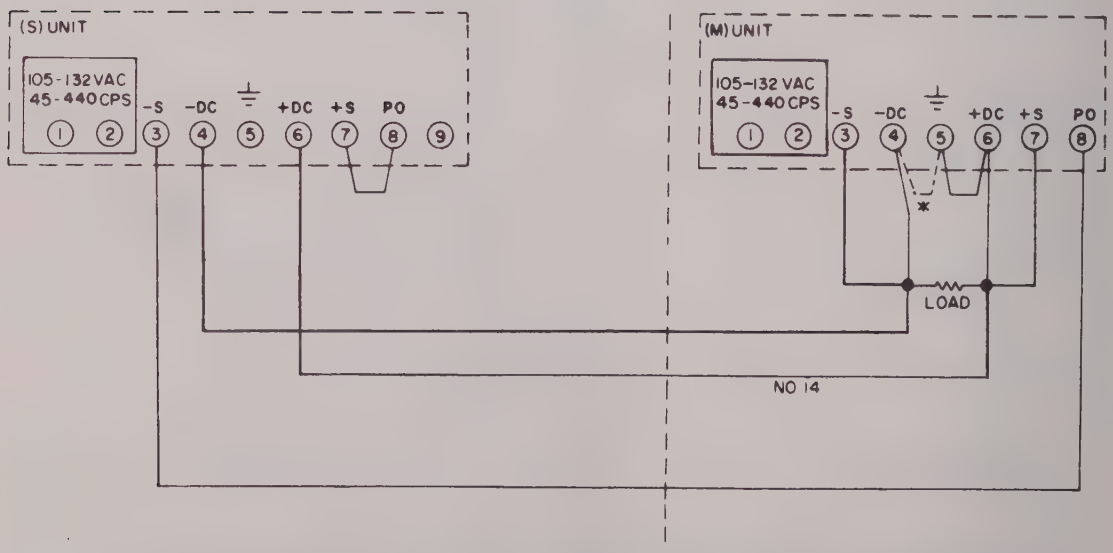
* MAKE ONLY ONE GROUND CONNECTION FOR THE SERIES COMBINATION; TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 6 ON (M) UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

Figure 7. Series Connection



NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5.

Figure 8. Parallel Connection, Local Sensing



NOTE.
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 6 AND RECONNECT TO TERMINALS 4 AND 5.

Figure 9. Parallel Connection, Remote Sensing

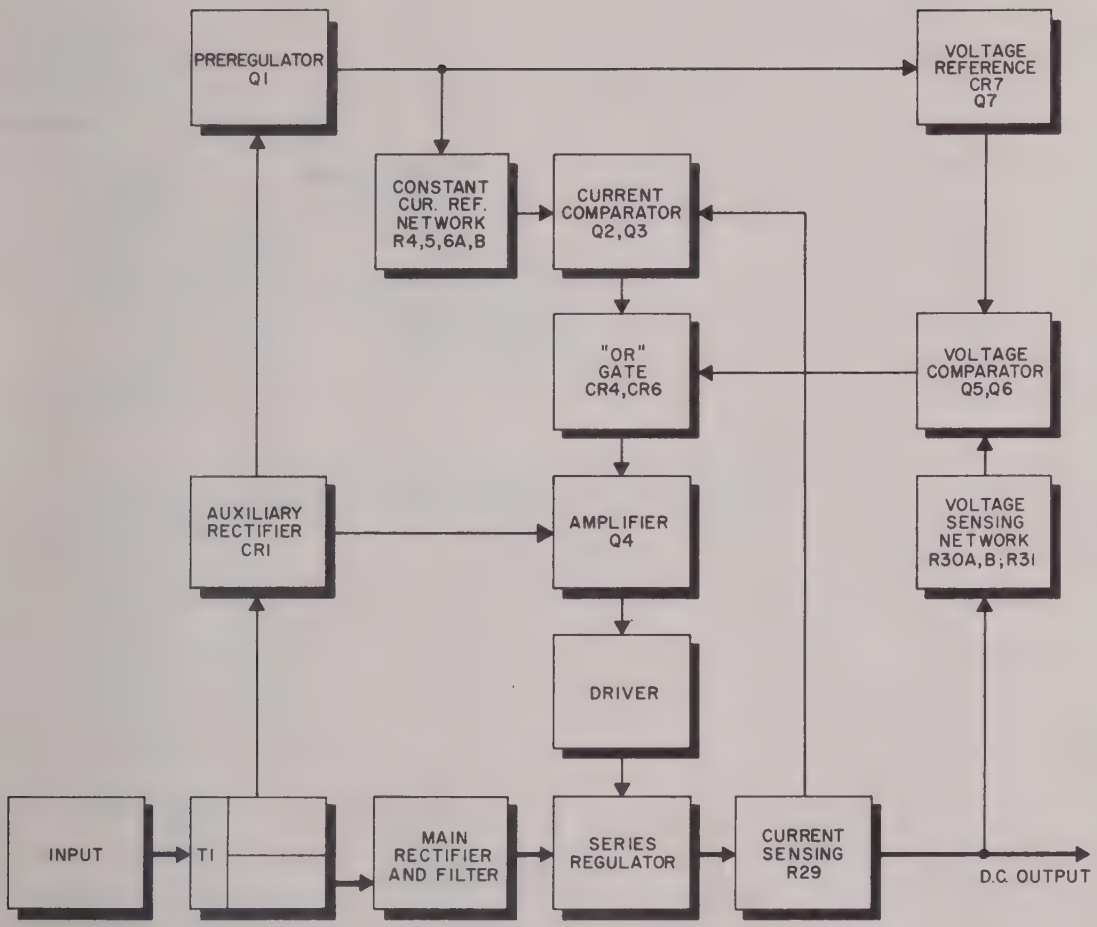


Figure 10. Typical Block Diagram

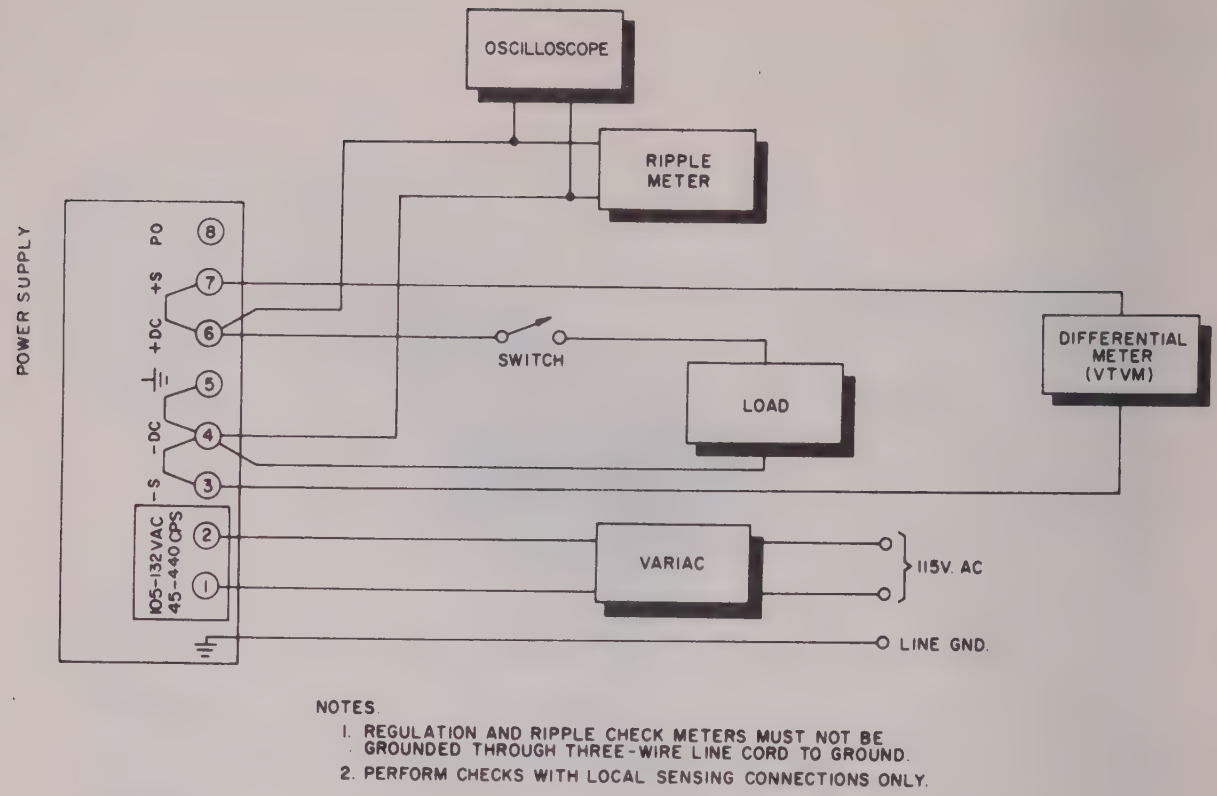


Figure 11. Test Connections For Constant Voltage Performance Checks

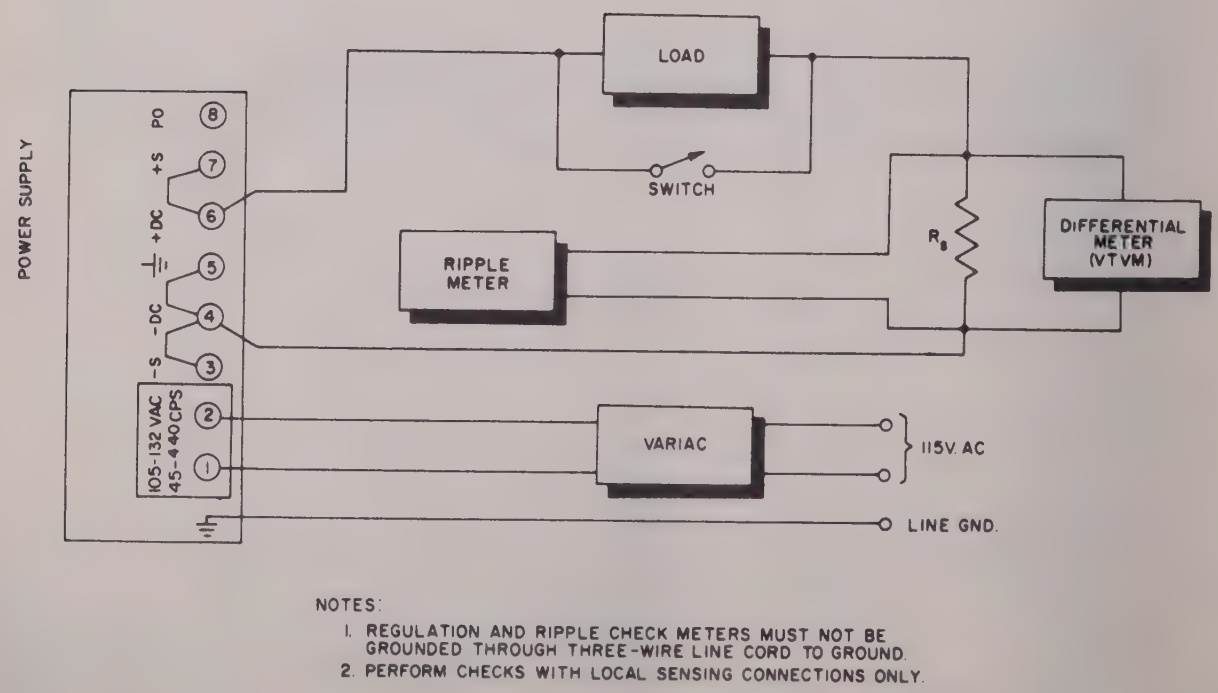


Figure 12. Test Connections For Constant Current Performance Checks

GENERAL DESCRIPTION

Rack adapter LRA-1 is designed for use in equipment racks where ruggedized mounting of units is required. The adapter can be used with or without chassis slides.

Rack adapter LRA-2 is designed for simple applications of rack installation where chassis slides and ruggedized mounting of equipment are not required.

Both rack adapter LRA-1 and LRA-2 can be used to install 1/4-rack or 1/2-rack power supply units into equipment racks. Each adapter can accept various combinations of 1/4 and 1/2-rack units up to four 1/4-rack units or two 1/2-rack units.

INSTALLATION OF 1/2 RACK UNITS INTO LRA-1

To install 1/2-rack power supply units, remove slide numbers 2 and 3 and/or 6 and 7, together with securing hardware and associated slide bar nut.

Using slide screws and slide bar nuts that were removed, store removed slides on the frame at the rear of the adapter where screw clearance holes are provided for securing each slide to the adapter.

SHIPMENT OF UNITS MOUNTED IN LRA-1

To protect the unit against damage from shock and vibrations when transporting adapter with installed units, eight universal tie-down mounting holes, located in the adapter base, at the rear of the rack adapter, are used to secure 1/4-rack and/or 1/2-rack units into the rack adapter. Secure each unit using two 6-32 x 5/8 screws, two lockwashers and two spacers installed from the bottom side of the rack adapter. See detail A for typical securing hardware. Eight spacers are supplied with rack adapter LRA-1.

RUGGEDIZED MOUNTING

When ruggedized mounting of units is required, follow the procedure described for SHIPMENT OF UNITS MOUNTED IN LRA-1. See detail A for typical securing hardware.

MOUNTING CHASSIS SLIDES

Mount chassis slides using the following hardware. To assure unrestricted mounting of units into the adapter designated screw lengths must not be exceeded. Insert screws into designated holes and secure slide in position using long bar nut supplied with rack adapter LRA-1.

CHASSIS TRAK NO. CTS.-116:
10-32 x 7/16 fl-hd (82°);
use A holes.

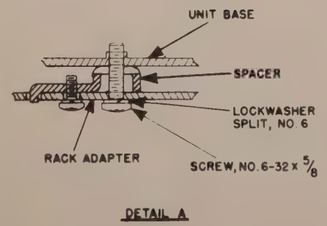
JONATHAN NO. 130 QD:
6-32 x 1/2 fl-hd (82°);
use B and C holes.

GRANT PULLEY NO. 4435:
6-32 x 5/16 fl-hd (100°);
use B and D holes.

USING BLANK PANELS AND BLANK CHASSIS

Blank front panels Model LBP-10 and LBP-20 are available for covering any 1/4-rack or 1/2-rack opening respectively. The blank panels can be used with rack adapter LRA-1 and LRA-2 whenever a 1/4-rack or 1/2-rack space in the adapter is not occupied by a unit. Secure each panel in position using four 6-32 x 3/8 panhead screws supplied with the rack adapter.

Paneled blank chassis Models LBC-10 (1/4-rack size) and LBC-20 (1/2-rack size) are available for any 1/4-rack or 1/2-rack equipment design package. These blank chassis enable the user of rack adapters LRA-1 and LRA-2 to design system equipment that can be packaged on ready-made chassis that are compatible with existing system components. Both blank chassis can be used with rack adapters LRA-1 and LRA-2.



DETAIL A

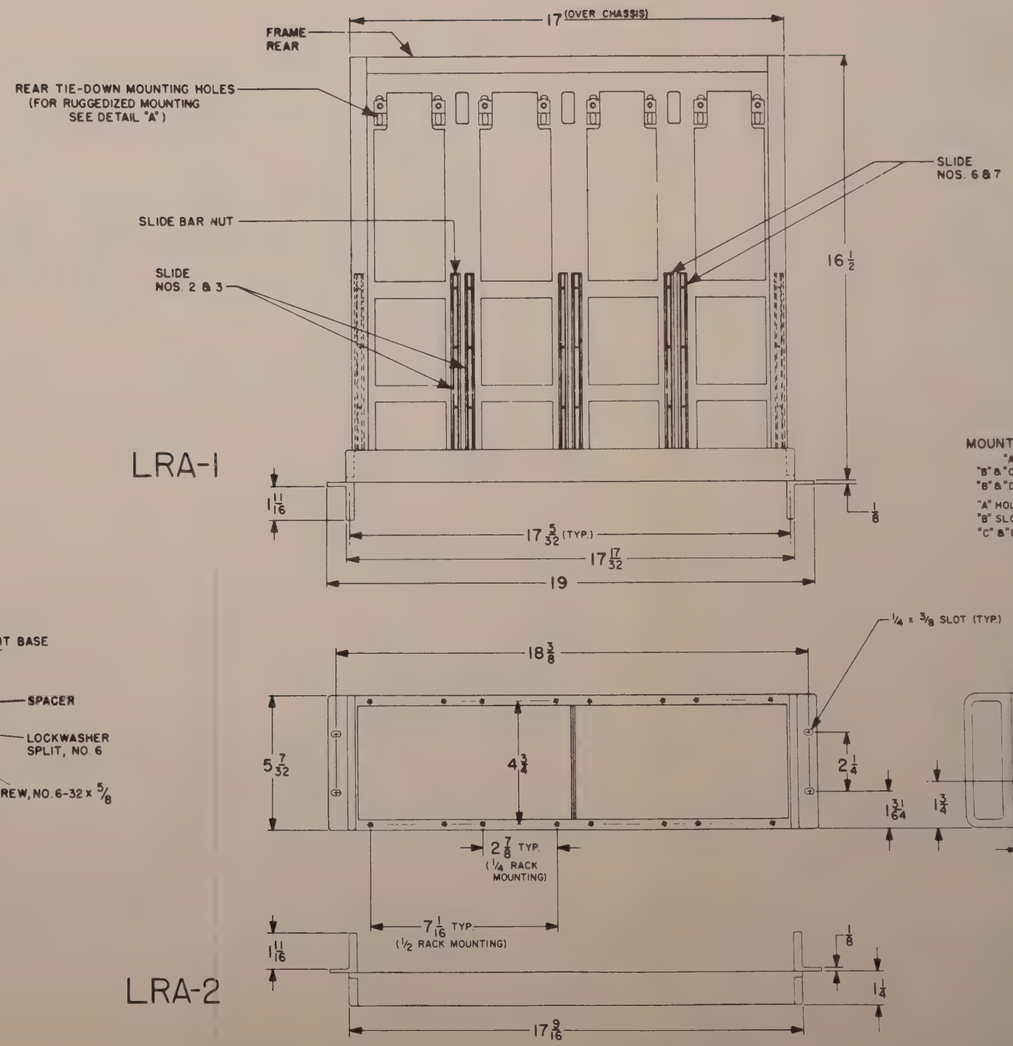
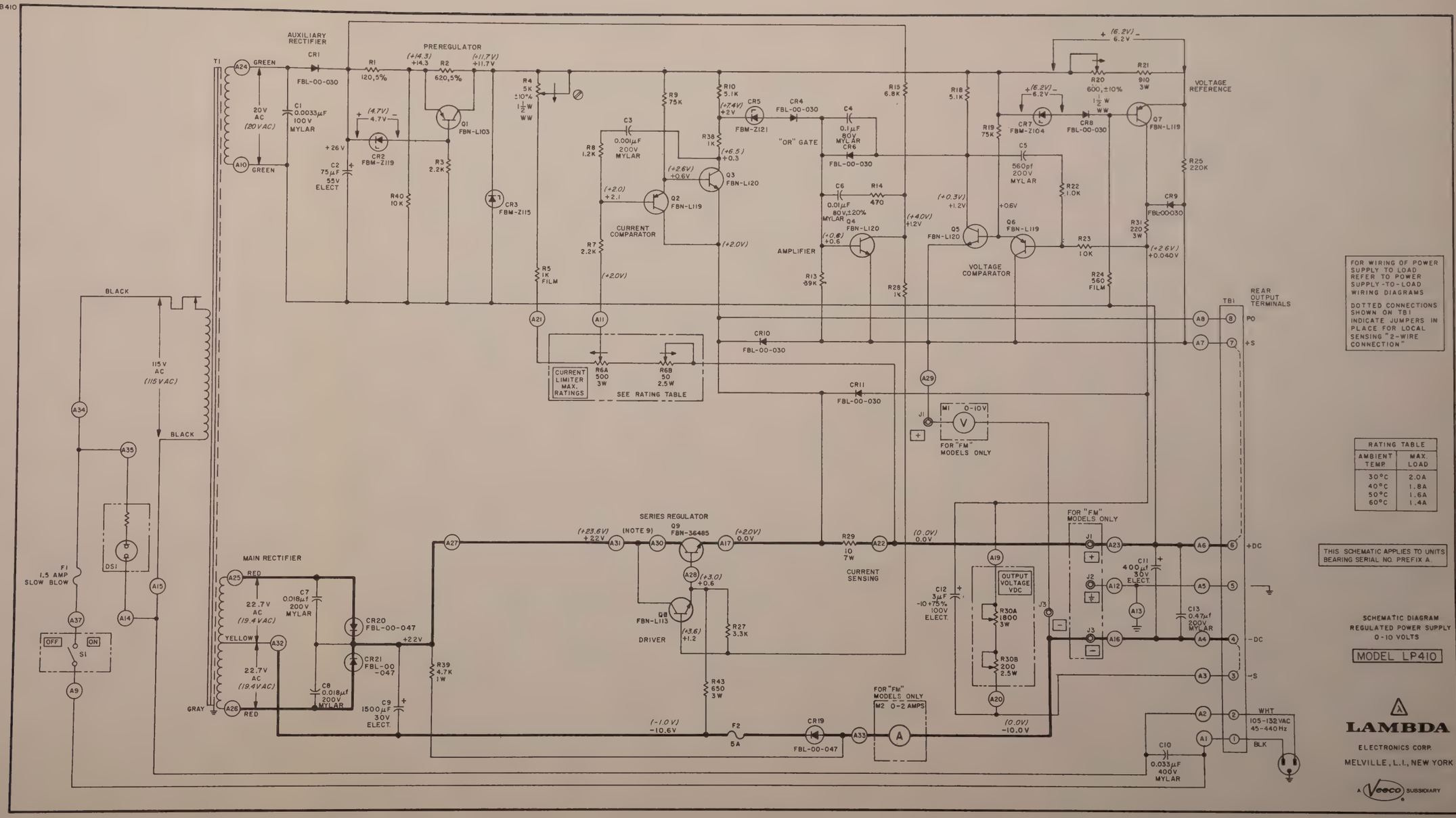

17 (OVER CHASSIS)
FRAME REAR
REAR TIE-DOWN MOUNTING HOLES (FOR RUGGEDIZED MOUNTING SEE DETAIL "A")
SLIDE BAR NUT
SLIDE NOS. 2 & 3
SLIDE NOS. 6 & 7
16 1/2
LRA-1
1 11/16
17 5/32 (TYP.)
17 17/32
19
1/8
TABLE OF WEIGHTS
MODEL
NET (LBS)
SHIPPING (LBS)
LRA-1 12 19
LRA-2 3 4
MOUNTING HOLES PROVIDED FOR CHASSIS SLIDES:
"A" HOLES - CHASSIS TRAK, INC. NO. CTS-116
"B" & "C" HOLES - JONATHAN MFG. CO. NO. 130 QD - LENGTH = 16, TRAVEL = 15
"B" & "D" HOLES - GRANT PULLEY CO. NO. 4435 - LENGTH = 16, TRAVEL = 15
"A" HOLES ARE 1/4 DIA.
"B" SLOTS ARE 5/32 WIDE x 1/2 LONG
"C" & "D" SLOTS ARE 5/32 WIDE x 1/4 LONG
1/4 x 3/8 SLOT (TYP.)
LONG BAR NUT (FOR OUTSIDE SLIDE MT'G.)
18 3/8
5 7/32
4 3/4
2 1/4
1 31/64
1 3/4
5 7/64
2 7/8 TYP. (1/4 RACK MOUNTING)
7 1/16 TYP. (1/2 RACK MOUNTING)
1 11/16
1/8
1 1/4
17 9/16
NYLON CUP WASHER

Figure 13. Rack Adapters LRA-1 and LRA-2

SCB410

NOTES

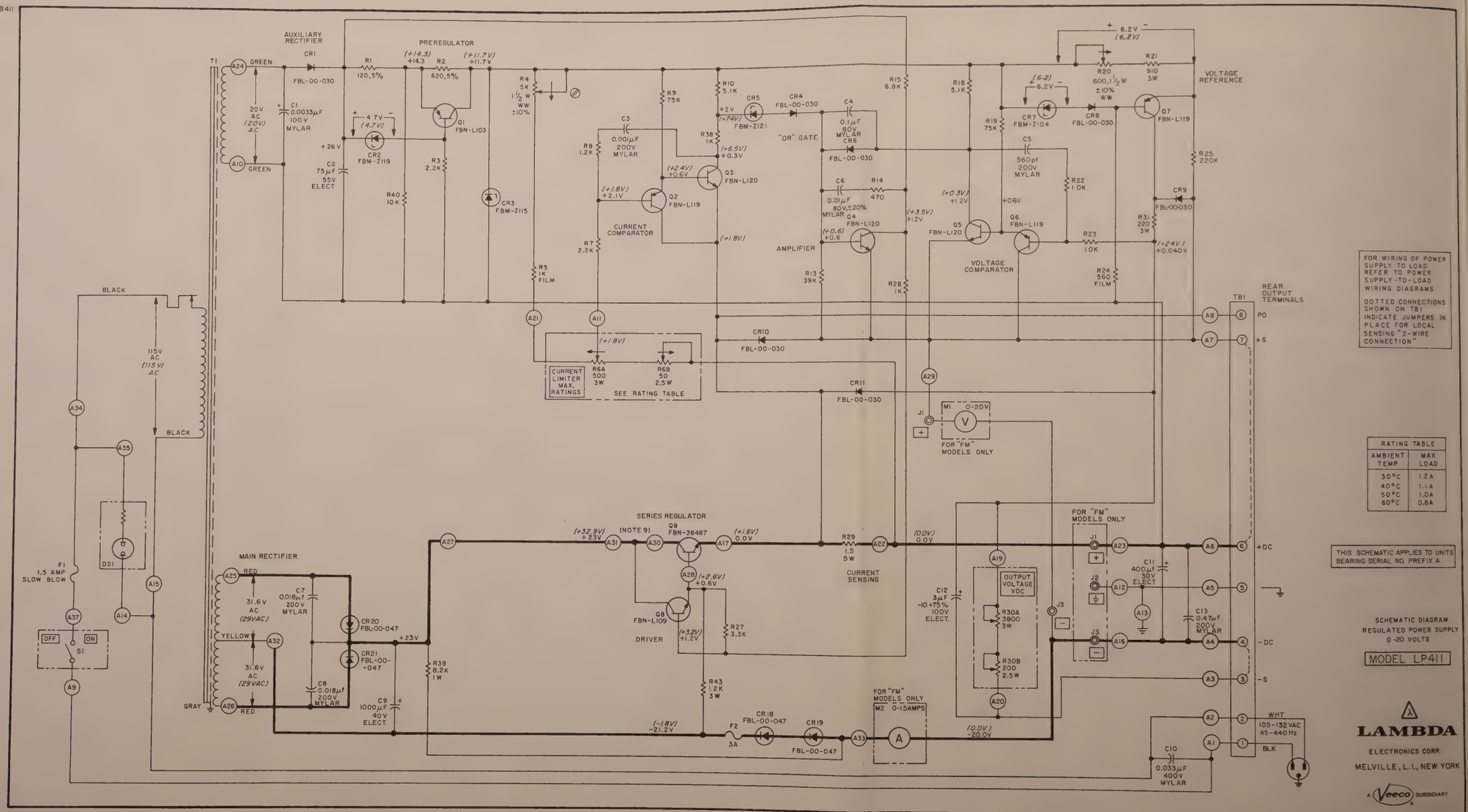
1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/2 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED.
3. RESISTOR TOLERANCES: COMPOSITION ±10%; WIREWOUND ±3% FILM ±5%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT
   - INDICATES CONNECTION TO CHASSIS.
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - INDICATES ACTUAL UNIT MARKING.
   - * SEE INSTRUCTION MANUAL
   - LAMBDA PT.#FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD OR TERMINAL BOARD.
6. DESIGNATIONS ARE LAMBDA PART NUMBERS
7.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS, CV AND CC INPUT: 115 VAC, 60 Hz; INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S(TERM. 7) & INDICATED POINTS UNLESS NOTED.
   - A. CONSTANT VOLTAGE
     READ NOS. NOT IN PARENTHESES
     OUTPUT: MAX RATED VOLTAGE, ZERO CURRENT
   - B. CONSTANT CURRENT
     READ NOS. IN PARENTHESES
     OUTPUT: 0 VOLTS, MAX. RATED CURRENT (SHORT CIRCUIT)
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. [ ] INDICATES FRONT-PANEL MOUNTED COMPONENT.



SCB411

NOTES

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/2 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED.
3. RESISTOR TOLERANCES: COMPOSITION ±10%; WIREWOUND ±3% FILM ±5%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT.
   - INDICATES CONNECTION TO CHASSIS.
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - INDICATES ACTUAL UNIT MARKING.
   - SEE INSTRUCTION MANUAL
   - LAMBDA PT. #FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD OR TERMINAL BOARD.
6. DESIGNATIONS ARE LAMBDA PART NUMBERS
7.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS, CV AND CC INPUT: 115 VAC, 60 Hz; INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED.
   - A. CONSTANT VOLTAGE
     READ NOS. NOT IN PARENTHESES
     OUTPUT: MAX RATED VOLTAGE, ZERO CURRENT
   - B. CONSTANT CURRENT
     READ NOS. IN PARENTHESES
     OUTPUT: 0 VOLTS, MAX. RATED CURRENT (SHORT CIRCUIT)
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. [ ] INDICATES FRONT-PANEL MOUNTED COMPONENT.



FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

RATING TABLE	
AMBIENT TEMP	MAX. LOAD
30°C	1.2A
40°C	1.1A
50°C	1.0A
60°C	0.8A

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A.

SCHEMATIC DIAGRAM
REGULATED POWER SUPPLY
0-20 VOLTS

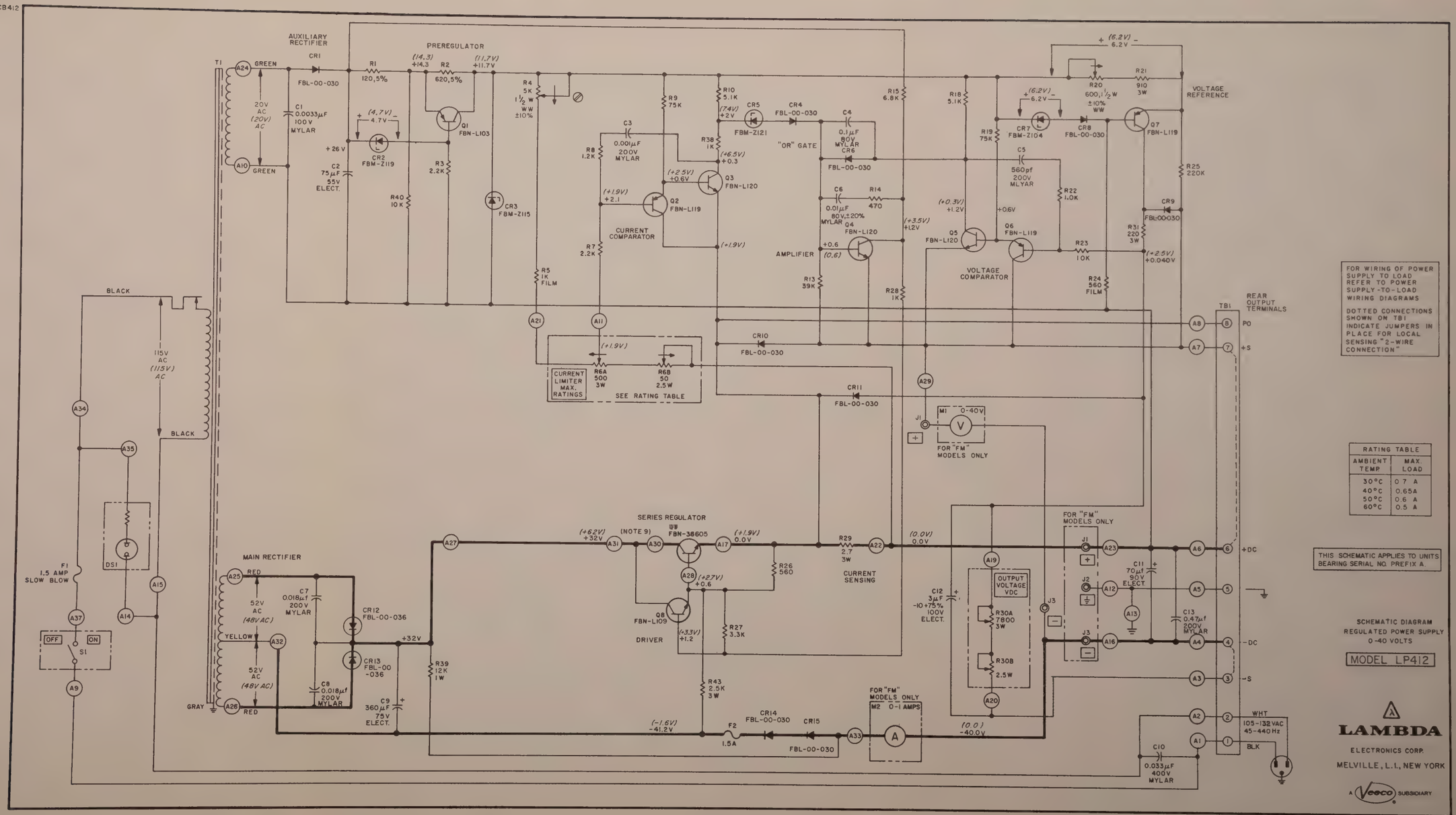
MODEL LP411

LAMBDA
ELECTRONICS CORP.
MELVILLE, L.I., NEW YORK
A Veeco SUBSIDIARY

SCB412

NOTES

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/2 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED.
3. RESISTOR TOLERANCES: COMPOSITION ±10%; WIREWOUND ±3% FILM ±5%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT
   - INDICATES CONNECTION TO CHASSIS.
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - INDICATES ACTUAL UNIT MARKING.
   - * SEE INSTRUCTION MANUAL
   - LAMBDA PT.#FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD OR TERMINAL BOARD.
6. DESIGNATIONS ARE LAMBDA PART NUMBERS
7.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS, CV AND CC INPUT: 115 VAC, 60 Hz; INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED.
   - A. CONSTANT VOLTAGE
     READ NOS. NOT IN PARENTHESES
     OUTPUT: MAX RATED VOLTAGE, ZERO CURRENT
   - B. CONSTANT CURRENT
     READ NOS. IN PARENTHESES
     OUTPUT: 0 VOLTS, MAX. RATED CURRENT (SHORT CIRCUIT)
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. [ ] INDICATES FRONT-PANEL MOUNTED COMPONENT.



SCB413

NOTES

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/2 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED.
3. RESISTOR TOLERANCES: COMPOSITION ±10%; WIREWOUND ±3% FILM ±5%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%; UNLESS OTHERWISE NOTED.
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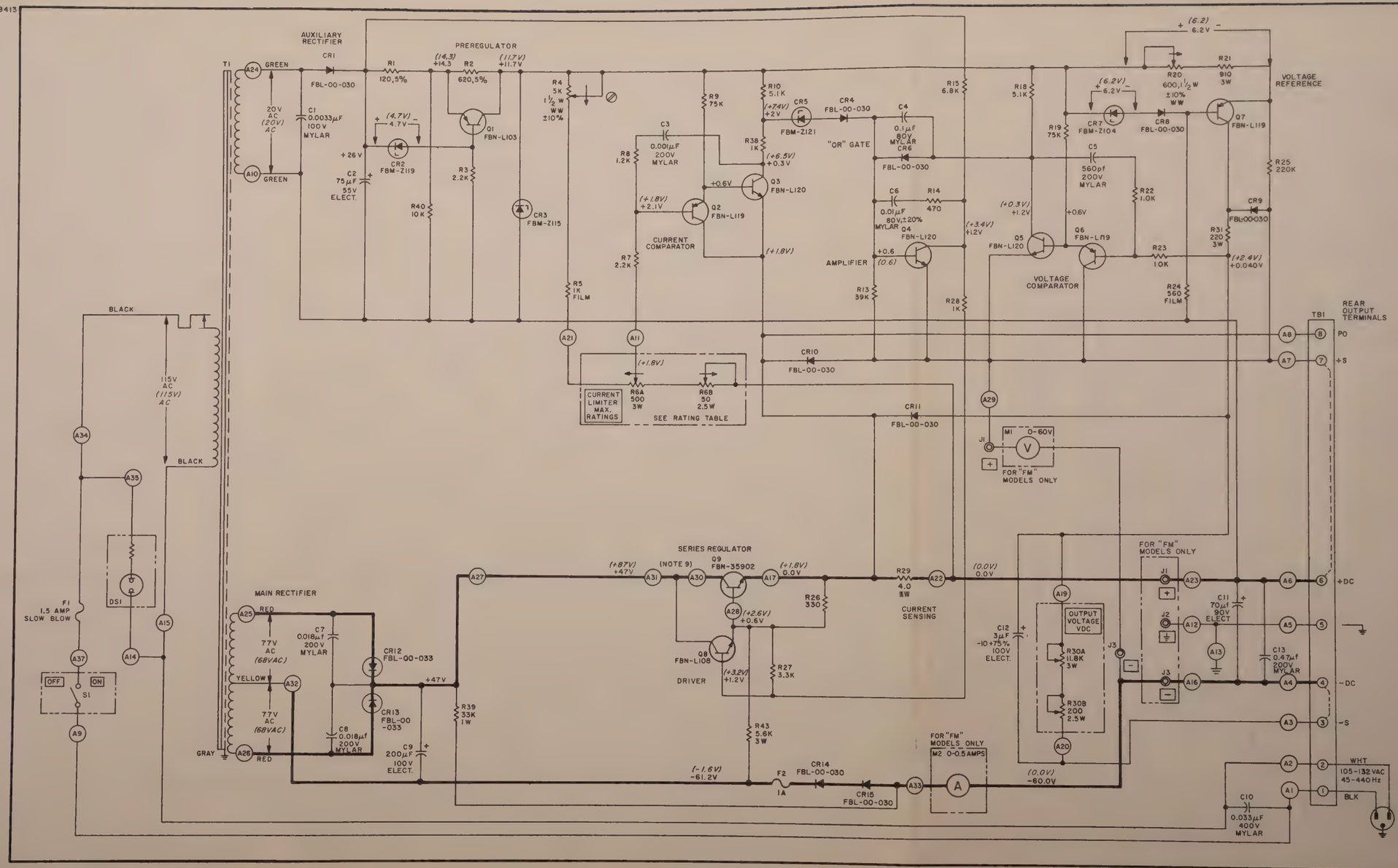
   - INDICATES CLOCKWISE ROTATION OF SHAFT
   - INDICATES CONNECTION TO CHASSIS.
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - INDICATES ACTUAL UNIT MARKING.
   - SEE INSTRUCTION MANUAL
   - LAMBDA PT.#FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD OR TERMINAL BOARD.
6. DESIGNATIONS ARE LAMBDA PART NUMBERS
7.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS, CV AND CC INPUT: 115 VAC, 60 Hz;
   INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED.
   A. CONSTANT VOLTAGE
      READ NOS. NOT IN PARENTHESES
      OUTPUT: MAX RATED VOLTAGE, ZERO CURRENT
   B. CONSTANT CURRENT
      READ NOS. IN PARENTHESES
      OUTPUT: 0 VOLTS, MAX. RATED CURRENT (SHORT CIRCUIT)
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. [ ] INDICATES FRONT-PANEL MOUNTED COMPONENT.



FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

RATING TABLE	
AMBIENT TEMP	MAX. LOAD
30°C	0.45A
40°C	0.41A
50°C	0.37A
60°C	0.33A

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A.

SCHEMATIC DIAGRAM
REGULATED POWER SUPPLY
0-60 VOLTS

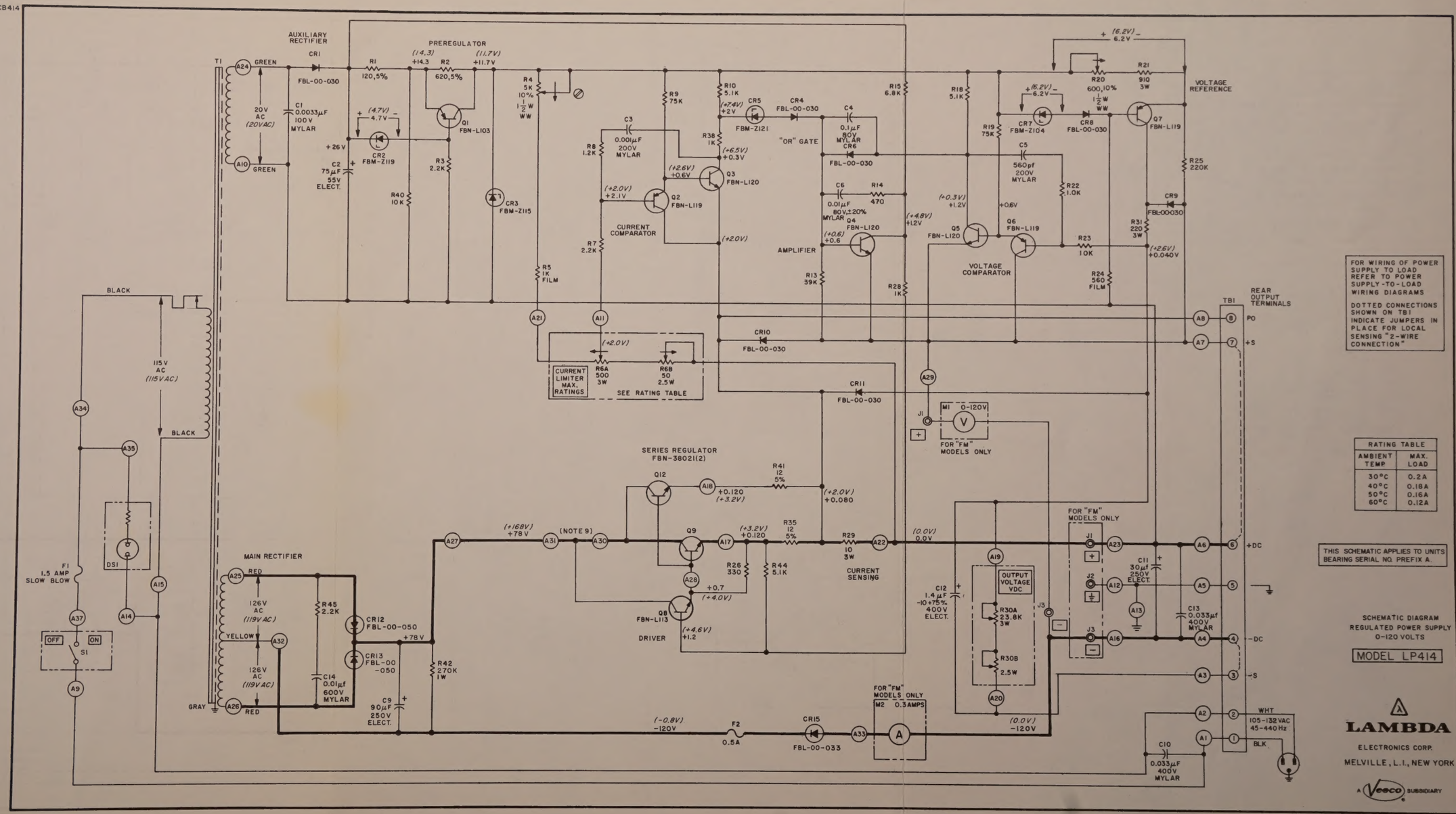
MODEL LP413

LAMBDA
ELECTRONICS CORP.
MELVILLE, L.I., NEW YORK
A Vesco SUBSIDIARY

SCB414

NOTES

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/2 WATT, RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED.
3. RESISTOR TOLERANCES: COMPOSITION ±10%; WIREWOUND ±3% FILM ±5%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%; UNLESS OTHERWISE NOTED.
5. SYMBOLS:
   - INDICATES CLOCKWISE ROTATION OF SHAFT
   - INDICATES CONNECTION TO CHASSIS.
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - INDICATES ACTUAL UNIT MARKING.
   - SEE INSTRUCTION MANUAL
   - LAMBDA PT.#FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD OR TERMINAL BOARD.
6. DESIGNATIONS ARE LAMBDA PART NUMBERS
7.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS, CV AND CC INPUT: 115 VAC, 60 Hz; INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED.
   - A. CONSTANT VOLTAGE
     READ NOS. NOT IN PARENTHESES
     OUTPUT: MAX RATED VOLTAGE, ZERO CURRENT
   - B. CONSTANT CURRENT
     READ NOS. IN PARENTHESES
     OUTPUT: 0 VOLTS, MAX. RATED CURRENT (SHORT CIRCUIT)
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. [ ] INDICATES FRONT-PANEL MOUNTED COMPONENT.



FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

RATING TABLE	
AMBIENT TEMP.	MAX. LOAD
30°C	0.2A
40°C	0.18A
50°C	0.16A
60°C	0.12A

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A.

SCHEMATIC DIAGRAM
REGULATED POWER SUPPLY
0-120 VOLTS

MODEL LP414

LAMBDA
ELECTRONICS CORP.
MELVILLE, L.I., NEW YORK
A Vesco SUBSIDIARY

SCB415

NOTES

1. RESISTOR VALUES ARE IN OHMS.
2. RESISTOR WATTAGE 1/2 WATT; RESISTORS ABOVE 2 WATTS ARE WIREWOUND UNLESS OTHERWISE NOTED.
3. RESISTOR TOLERANCES: COMPOSITION ±10%; WIREWOUND ±3% FILM ±5%; UNLESS OTHERWISE NOTED.
4. CAPACITOR TOLERANCES: ELECTROLYTIC -10%, +100%; MYLAR ±10%; UNLESS OTHERWISE NOTED.
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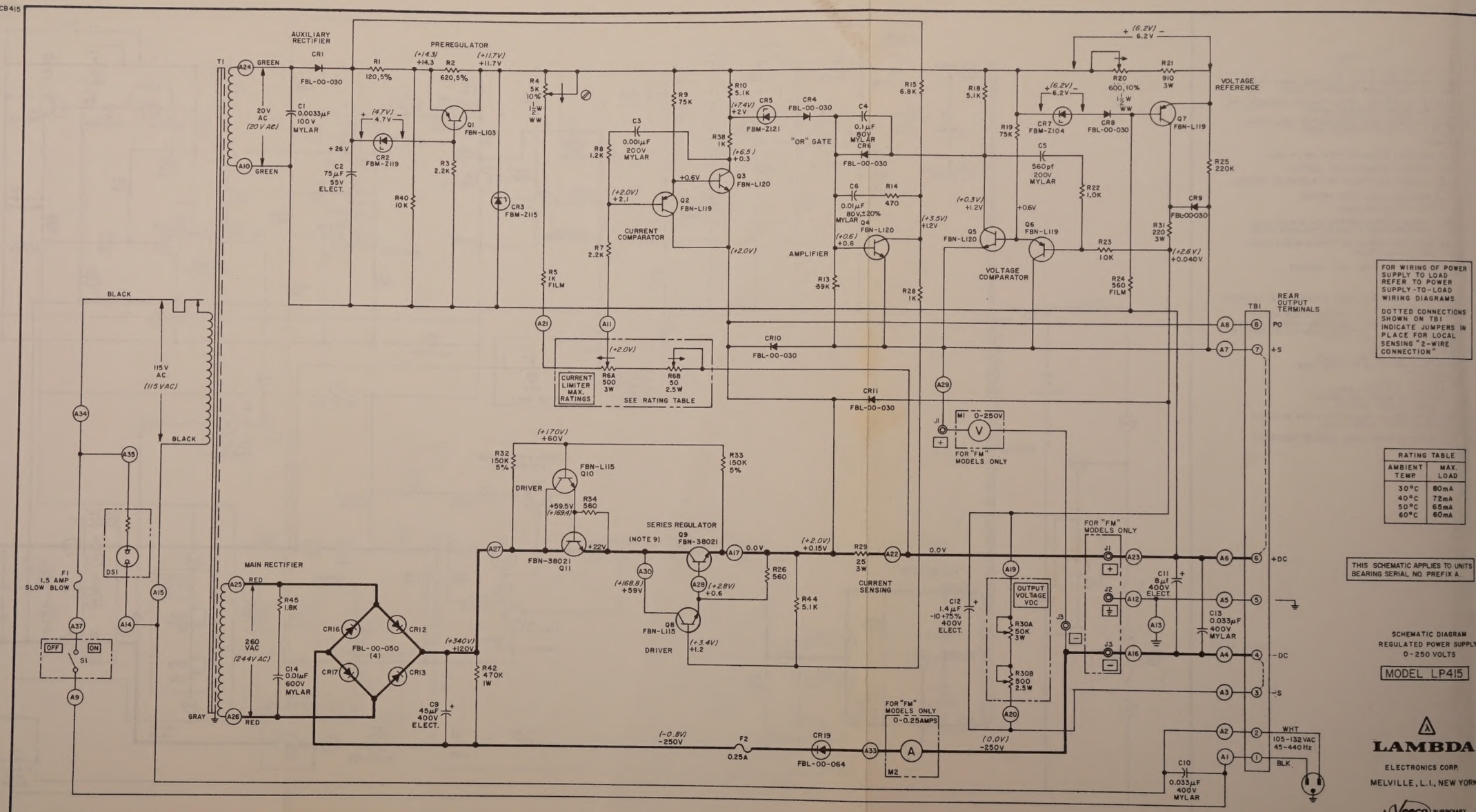
   - INDICATES CLOCKWISE ROTATION OF SHAFT
   - INDICATES CONNECTION TO CHASSIS.
   - INDICATES ADJUSTMENT OR CALIBRATION CONTROL.
   - INDICATES ACTUAL UNIT MARKING.
   - SEE INSTRUCTION MANUAL
   - LAMBDA PT.#FBL-00-030; USE IN 4002 DIODE FOR REPLACEMENT UNLESS OTHERWISE NOTED.
   - INDICATES TERMINAL ON PRINTED WIRING BOARD OR TERMINAL BOARD.
6. DESIGNATIONS ARE LAMBDA PART NUMBERS
7.
8. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS, CV AND CC INPUT: 115 VAC, 60 Hz; INDICATED VOLTAGES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 20,000 OHMS/V VOLTMETER BETWEEN +S (TERM. 7) & INDICATED POINTS UNLESS NOTED.
   - A. CONSTANT VOLTAGE
     READ NOS. NOT IN PARENTHESES
     OUTPUT: MAX RATED VOLTAGE, ZERO CURRENT
   - B. CONSTANT CURRENT
     READ NOS. IN PARENTHESES
     OUTPUT: 0 VOLTS, MAX. RATED CURRENT (SHORT CIRCUIT)
9. COAT BOTH SIDES OF INSULATING WAFER WITH DOW CORNING NO. 340 SILICONE GREASE.
10. [ ] INDICATES FRONT-PANEL MOUNTED COMPONENT.



FOR WIRING OF POWER SUPPLY TO LOAD REFER TO POWER SUPPLY-TO-LOAD WIRING DIAGRAMS

DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING "2-WIRE CONNECTION"

RATING TABLE	
AMBIENT TEMP	MAX. LOAD
30°C	80mA
40°C	72mA
50°C	65mA
60°C	60mA

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIX A.

SCHEMATIC DIAGRAM
REGULATED POWER SUPPLY
0-250 VOLTS

MODEL LP415

LAMBDA
ELECTRONICS CORP.
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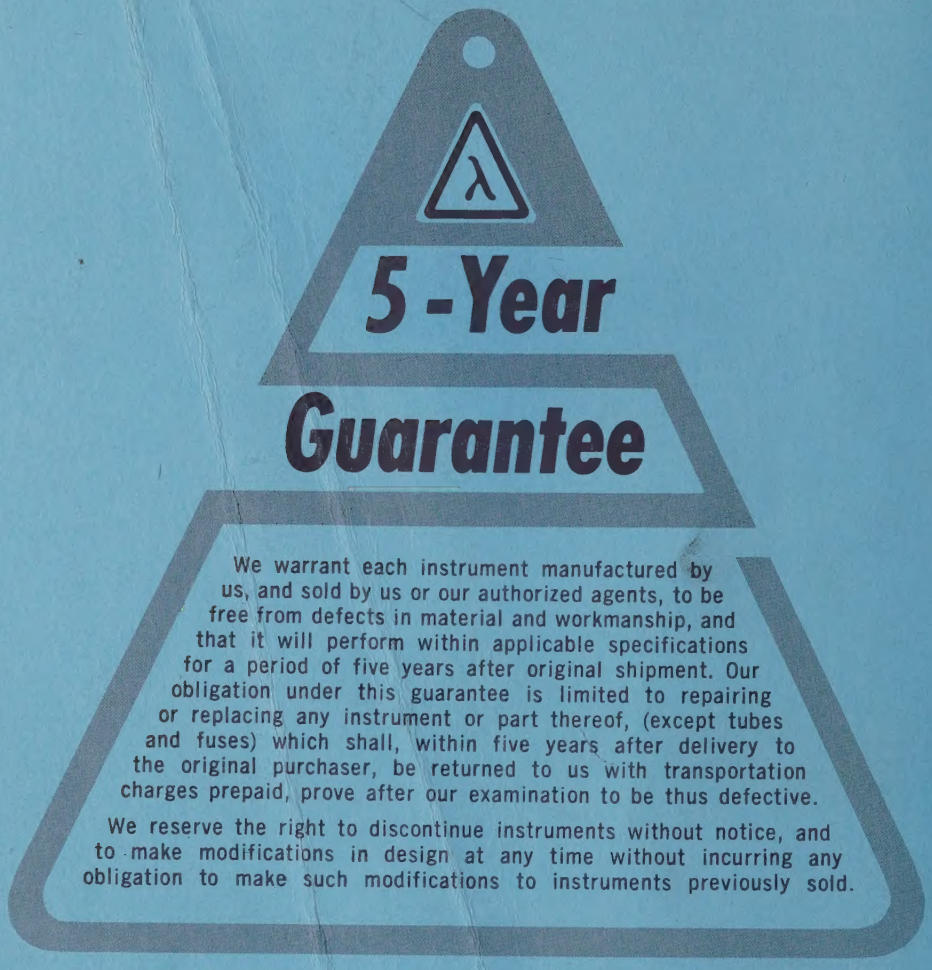

5-Year Guarantee

We warrant each instrument manufactured by us, and sold by us or our authorized agents, to be free from defects in material and workmanship, and that it will perform within applicable specifications for a period of five years after original shipment. Our obligation under this guarantee is limited to repairing or replacing any instrument or part thereof, (except tubes and fuses) which shall, within five years after delivery to the original purchaser, be returned to us with transportation charges prepaid, prove after our examination to be thus defective.

We reserve the right to discontinue instruments without notice, and to make modifications in design at any time without incurring any obligation to make such modifications to instruments previously sold.

LAMBDA ELECTRONICS CORP.

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MP MASTER

MA28846

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